ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Vol. XXXVII., No. 7.

TABLE OF CONTENTS.

ENGINEERING NEWS OF THE WEEK..... 97
The Lachine Rapids Power Plant, Montreal, P. Q. (with two-page engraving and other illustrations) 98
Experiences with the Contract System of U. S. Land Surveys in Florida 101
Footguard for Frogs, Switches and Guard Rails (illustrated) 102
Steam Engine Governors (illustrated)..... 105
A Direct-Coupled Gas Engine and Dynamo (illustrated) 105
Wooden Smokejack for Roundhouses (illustrated)... 106
A New Box Column (illustrated) 107
The Presence of Hydrogen, Hydrocarbons and Nitrogen Peroxide in Boiler Furnace Gases..... 107
The Report on Through Train Service Across the Brooklyn Bridge (illustrated) 107
The Bryant Revolving Molding Machine (illustrated) 110
The Eads Jetties and the Pass a Loutre Crevasse... 111
The New York Cycle Exhibition 111
EDITORIAL NOTES 104
An Investigation of the Economic Advantage of a Lake and Seaboard Deep Waterway—The Board of Experts Report on Through Traffic Over the Brooklyn Bridge—An English Idea of Rapid Work in Bridge Shifting—The Lowest Prices on Record for Steel Rails and Cast-Iron Pipe.
EDITORIAL:
Concerning the Contract System for Public Land Surveys 105
LETTERS TO THE EDITOR 105, 106
West Bluff Sewer System, Peoria, Ill.—Cost of Incandescent Electric Lights in Montclair, N. J.—Checking Multiplication by Excess of Nines—The Experiences of Some Recent Graduates in Engineering.

A GOVERNMENT ARMOR PLANT, to cost $1,500,000, is to be recommended by the Senate Naval Committee. This appropriation, if made, is to be placed at the disposal of the Secretary of the Navy, to be used in case the government does not receive from manufacturers bids for armor coming within a limit fixed by law. At its next meeting the committee will fix upon a price for armor. The manufacturers ask $450 per ton. Secretary Herbert is willing to allow $400, but Senator Chandler says $300 per ton is enough. In commenting upon the report of Secretary Herbert, regarding the cost of manufacturing armor plate, Mr. H. C. Frick, Chairman of the Board of Managers of the Carnegie Company, objects to the estimate of $423.41 per ton as being the total cost. The sinking fund to cover depreciation was put by the government estimate at 4%, thus allowing 25 years for building a navy, where the company had estimated upon 10 years of active work. The $3,537,000 given as the cost of the armor plant, says Mr. Frick, does not include $650,000 for erecting a special mill to roll light armor. Mr. R. P. Linderman, of the Bethlehem Company, also says that instead of $3,351,000, invested on account of new plant, the actual investment by his company was $6,351,000. Both companies ask to submit their claims to arbitration. On Feb. 15 Congressman Lorimer, of Illinois, introduced a bill in the House authorizing the Secretary of the Navy to make a 20-year contract with the Illinois Steel Co. for the supply of armor-plate at $200 per ton. The company agrees to put up a plant costing about $3,500,000 if this contract is awarded to them. Meanwhile, Chief Constructor Hichborn advocates a radical change in the present system of supplying armor plate and proposes that shipbuilders be hereafter required to furnish armor as well as ships, reserving to the government the right of inspection. He says that some foreign nations follow this practice with economical results as to time and money. Former Secretary of the Navy Tracy favored this plan. Mr. Hichborn contends in his letter now being discussed by the House Committee on Naval Affairs that the plan proposed would decrease cost of armor by removing many existing complications in the preparation of plans and discrepancies in figures, dimensions and requirements for acceptance and delivery.

THE MANUFACTURE OF THE FIRST ARMOR plates is claimed by the Parkgate Iron Works, of Rotherham, England. This firm rolled many of the heavy plates for the "Great Eastern," in 1857, and one of these plates was 27 ft. 3 ins. long, 3 ft. 3 ins. wide and weighed 41 cwt. When the French armored ship "La Glorie" appeared and a demand arose for a better protection for British ships this firm supplied 2,000 tons of plates, from 3 to 4½ ins. thick, for H. M. S. "Terror," launched in 1856. Mr. Charles Stoddart, managing director of the Parkgate works, says that Sir John Brown, who is usually credited with the invention and first rolling of armor plate, did not see "La Glorie" until 1860, and plate of this type was not rolled in Sheffield until 1862.

SIR. WM. ARMSTRONG, WHITWORTH & CO., LIMITED, is the name of a new firm resulting from the amalgamation of the old firms of Sir. W. G. Armstrong, Mitchell & Co., and Sir Joseph Whitworth & Co. The shareholders of the latter company receive $37.50 in cash for each $50 share and three $5 shares valued at $12.50 each.

THE PLUM BEACH LIGHT, in the west passage of Narragansett Bay has its substructure completed. A caisson of heavy timbers, 35 ft. square and 10 ft. 8 ins. high, was first floated into position and in this was placed an iron cylinder, 33 ft. diameter, and both were then sunk in 17 ft. of water at mean low tide. This cylinder was provided with a bottom working chamber 6 ft. high, and the space above and around the communicating shaft was filled with Portland cement concrete. Compressed air was used, up to 23 lbs. pressure per sq. inch, to sink the iron cylinder 30 ft. into the bottom of the bay at this point. The contract called for 23 ft.; but on arriving at that point a bed of quicksand was found slightly below it and the greater depth was determined upon. The structure as it now stands is 50 ft. high above the bottom edge, and cost $60,000; it will be surrounded by 1,900 tons of riprap and will cost from $10,000 to $15,000 to complete.

TORPEDO BOAT NO. 6, built by the Herreshoff Bros., made her official trial trip at Newport on Feb. 10. In five runs over a 12-mile course, or 60 miles in all, she made an average of 28.75 knots. The several runs showed 28.97, 28.85, 28.78, 28.87 and 28.23. The reduction in the last run was due to a slight disarrangement of the machinery, reducing her blower power and consequent steam pressure. The general result was highly satisfactory, as there was very little vibration, even over the screw, a small wave, and at no time was the steam limit of 225 lbs. reached nor did her propeller reach 400 revolutions per minute. The indications are that she can exceed both, and naval officers anticipate that with a trained crew she will make 30 knots.

THE NICARAGUA CANAL BILL has been formally abandoned for this session by Senator Morgan. But he will bring it up again at the extra session expected after March 4.

SPANISH-AMERICAN MERCHANTS, delegates from Chambers of Commerce, in Colombia, Peru, Buenos Ayres, Brazil and Venezuela, are to visit this country in June next and be present at the annual meeting of the Philadelphia Museum. They will then visit the principal manufacturing establishments of this country and be entertained by boards of trade in various large cities. About 40 or 50 delegates from South America will attend, and others are expected from Mexico and some of the Central American states.

THE EXCESS OF EXPORTS OVER IMPORTS, for the seven months ending Jan. 31, says the Chief of the Bureau of Statistics, was $292,964,231, as compared with an excess of $46,248,252 for the same period ending Jan. 31, 1896, a gain of $246,715,979. This represents the total values of the exports of merchandise from the United States.

A STEEL CHIMNEY FOR JAPAN, 175 ft. high, 7 ft. 3 ins. diameter and weighing over 90,000 lbs., has been shipped by the Philadelphia Engineering Works. It is for an electric light plant in Yokohama.

THE FILTER PLANT AT ELMIRA, N. Y., wrongly stated in our last issue as not yet in operation, has been running since Jan. 19. When the injunction, also noted last week, restraining the Elmira Water-Works Co. from using alum under the Hyatt patent was served, Feb. 8, the alum was shut off. The Paget process of introducing alum, said to be materially different from the Hyatt process, is now being installed. The above information is given on the authority of the Morison-Jewell Filtration Co., contractors for the filter plant.

SAND FILTRATION FOR THE WATER SUPPLY of Albany, N. Y., is recommended by the water commissioners in their annual report, just presented to the common council. The recommendations are in accordance with an exhaustive report by Mr. Allen Hazen, of Boston, on the purification of the supply. The plan is to locate filter beds on flats above the lumber district, water to be taken from the Hudson River through 1,400 ft. of 54-in. steel pipe, and lifted by centrifugal pumps to a 15,600,000-gallon settling reservoir. There would be eight filter beds, covered with a vaulted masonry roof and earth. These would have an effective area of 246,000 sq. ft., or 5.6 acres, with a daily capacity of 15,000,000 gallons, allowing one bed to be out of use for cleaning. From the filters a 48-in. steel pipe would be laid in the bed of the Erie Canal to the present pumping station. The estimated cost of the plant is $478,000 for construction and $16,000 per year for operation. Capitalizing the operating expenses at 5% gives $320,000, or a total estimated cost of $798,000. The corresponding cost of substituting for the filter beds a gravity mechanical filtration plant of the same capacity, at the same site, is estimated by Mr. Hazen at $742,000. This includes about $300,000 for construction and the capitalization of $22,000 of operating expenses. Mr. Hazen thinks the mechanical filters should not be put in until after experiments have been made to determine the details required by local conditions, which might make up for the difference in cost between the two processes. Altogether he advises sand filtration. His estimates for mechanical filtration include 48 wooden filter tanks, with a filtering area of 5,760 sq. ft., which at two gallons per square foot per minute gives 15,000,000 gallons per day, with five tanks out of use for cleaning.

ARBITRATORS IN THE PEORIA WATER CASE have awarded the Receiver for the Peoria Water Co. $40,471 of the $46,444 claimed from the city for water furnished it during the last quarter of 1894, and the whole of the years 1895-6. Nearly the whole sum is for hydrant rentals. Interest charges of $1,825 were disallowed as not lawful on city bills of this sort, and $3,526 was also deducted as being in excess of the amount the city could lawfully contract to pay for water. There was also deducted from the bill $1,049 for shortage of water during a drought, and $193 for expenses incurred on that account by the city. A charge of $1,240 for water furnished the brickyard of the city workhouse was cut in half. The arbitrators decided that the city had not suffered because of the failure by the company to maintain the standpipes, and that in general the contract had been complied with, except in the matter of shortage of supply. The arbitrators were Gen. John McNulto, of Chicago; Geo. H. Benzenberg, M. Am. Soc. C. E., of Milwaukee, representing the city, and Robert Moore, M. Am. Soc. C. E., of St. Louis, representing the company. Mr. Moore dissented from the deductions allowed by the other arbitrators. Mr. Cornelius B. Gold, 15 Wall St., New York city, is Receiver of the Peoria Water Co.

THE REMOVAL OF THE 42ND ST. RESERVOIR, in New York city, has been ordered, the work to be done as soon as the large water mains, now being laid in Fifth Ave., are completed, as far as 38th St.

FREE WATER IN BOSTON, as it is popularly but erroneously called, would be the result of the passage of a bill introduced in the Massachusetts legislature. The bill provides for including all water-works expenses in the general tax levy.

THE SUIT AGAINST THE ALLEGED CAST-IRON pipe trust, noted in our issue of Jan. 21, 1897, as brought by the United States, has been decided in favor of the trust by Judge C. D. Clark, of the U. S. Court, at Chattanooga. The following is given in the press reports as a part of the decision:

Federal authority exists only when a monopoly or contract in restraint of trade assumes such form or has such effect as to go beyond any common lay conception of these terms and interferes directly and substantially with interstate commerce of commerce with foreign nations, and this it must do directly and not indirectly. I am unable to perceive that the act of Coingress can be regarded as applicable o the association under consideration.

The purpose of the association and of the "bonus" feature was not to rob the public but for the purpose of private gain.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a derailment on the Union Pacific Ry. in the yards at Omaha, Neb., Feb. 9. A switch leading from the main track to the yard freight tracks was open as the switchman was expecting a freight train, but the man finally concluded that a passenger train would arrive first and had started to go to the switch to close it. This train, the eastbound Overland express, arrived first, but the switchman had not time to get to the switch and the fireman did not see him signaling the danger. The train consisted of nine mail, baggage and sleeping cars and was running at high speed. The engine left the track on the sharp curve of the turnout, and was upset, while all the cars were derailed. The fireman was killed and the engineman badly hurt. The train was about two minutes ahead of its usual time, but it would seem to be very lax management which let the switchman to guess which train would arrive first.

A FALL OF ROCK in the Freeman talc mine at Talcville, N. Y., Feb. 13, buried six miners, none of whom were got out alive.

AN AMMONIA CYLINDER BURST while under test at the Cumberland Brewery, Feb. 11. The cylinder had been repaired and was being tested under pressure, but it is said that the gage ceased to register at 300 lbs. per sq. in., and that the actual pressure was very much higher. The cylinder cover was blown off and the pieces went up through three floors. Nobody was hurt.

THE STEAMER "PENNLAND" of the American Line was disabled while at sea recently by the breakage of a cylinder. Another steamer signalled the "Pennland" but the latter reported that repairs were being made and that no help was needed. The "Pennland" left Liverpool Jan. 27.

THE LACHINE RAPIDS POWER PLANT, MONTREAL, P. Q.

(With two-page engraving.)

By Wm. I. Bishop, Student. Can. Soc. C. E.

The problem of utilizing the power of the St. Lawrence River at Lachine Rapids, near Montreal, is one which has for many years engaged the attention of engineers and capitalists. Their almost unanimous opinion has been, however, that although considerable power could be obtained during the summer months, the drowning of the rapids during high water would so reduce this that any scheme requiring continuous power the whole year round would not be feasible. Support was given to this idea by facts observed during the running of a small grist mill erected on the site, for which power was obtained by throwing out a small wing dam. This mill was compelled to shut down during a part of the winter, owing to back water. Another serious objection was that great quantities of frazil or anchor ice run through the rapids almost all winter, and it was thought impossible to prevent its filling up the head race and wheels.

About five years ago Messrs. T. Pringle & Son and W. McLea Walbank, of Montreal, after a careful study of the question, came to the conclusion, (which has been proved since the river bed has been laid bare), that the backing up of the water and drowning of the rapids was caused by the great bars of rock which rise out of the river bed at an acute angle, facilitating the collection of frazil and the formation of natural ice dams.

The Lachine Rapids are probably the most famous of the series of rapids along the St. Lawrence River from Lake Ontario to Montreal. Everyone who has ever taken the steamer trip down them, which is one of the most enjoyable experiences of every pleasure-seeker's visit to that city, will recall the rock barriers, which make their presence manifest to the practiced eye by the turmoil of the waters, even when wholly submerged.

Above the rapids the river widens into a broad expanse, known as Lake St. Louis, some six miles wide and 14 miles long. The rapids themselves are about five miles in length, and their total fall is about 30 ft. Briefly stated, the plan for power development which is being carried out by the Lachine Rapids Hydraulic & Land Co., is to project a dam into the stream at a point about one mile above the foot of the rapids, and by a dike parallel to the river bank and extending up stream 5,000 ft. from the river end of this dam, to make a broad head race which will take water from a point where the water on the rapids is about 11 ft. higher than at the dam. Below the dam there is a further fall of about 10 ft. in a distance of about a mile to the foot of the rapids.

The works are designed to utilize 15,000 cu. ft. of water per second, which will be about 10% of the entire flow of the river at low water.

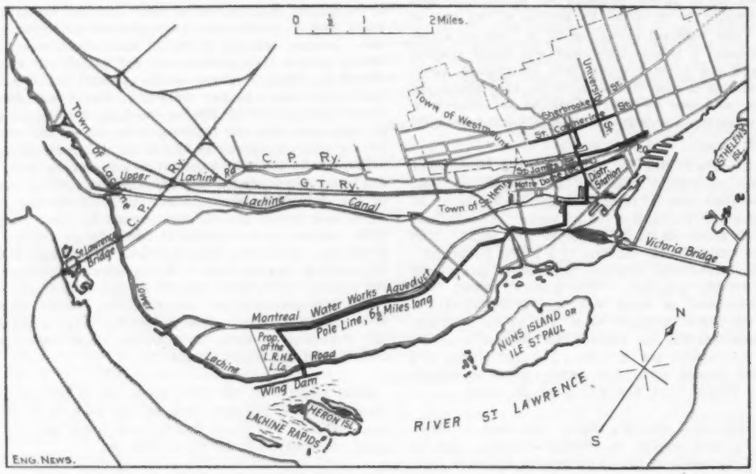


FIG. 1.—MAP SHOWING THE LOCATION OF THE POWER PLANT AND POLE LINE OF THE LACHINE RAPIDS HYDRAULIC AND LAND CO.

The general map of the rapids (Fig. 1) gives a good idea of the location of the company's power plant with reference to the rapids and the city of Montreal.

General Description of Works.

By reference to the general plan (Fig. 2) it will be noted that the present scheme as now being carried out will consist of: (1) A head race 3,705 ft. long, formed by a wing dam composed of a 300-ft. masonry ice breaker at the entrance, 350 ft. of overflow cribwork and 360 ft. of cribwork [illegible] ried up square to the same level as the top of the piers of the main dam. (2) A main dam [illegible] masonry piers on concrete foundations, the piers being 4 ft. thick and 17 ft. high above the level of the floor of the flumes and the top of the foundation. The piers form 36 flumes, three waste weirs and the foundations for three power houses. (3) A guard dam forming the tail race, consisting of 300 ft. of cribwork 10 ft. wide and 1800 ft. of embankment formed of rock taken from excavations. (4) A system of booms and cribwork piers designed to keep the wheels clear of floating ice, driftwood, grass, etc.

The head race is to be excavated to a depth of 12 ft. below the top of the overflow dam, and is at the narrowest point near the entrance 525 ft. wide, with a sectional area of 6,300 sq. ft., so that, allowing a discharge of 200 cu. ft. per second from each wheel, or a total of 14,400 cu. ft. for 72 wheels, the velocity of flow past this point will amount to about 2.3 ft. per second. As the head race widens out to nearly 1,000 ft. at the flumes, this velocity will, of course, be much reduced, so that there will be little, if any, lost head, due to an excessive speed of current.

The current in the river just above the entrance to the head race runs at the rate of about six miles per hour, and this striking a body of water moving at the rate of only ⅔-mile per hour will give it a tendency to strike almost directly outwards, carrying with it most of the frazil, driftwood, etc., that it may contain. It is also a fact that the current has always had a tendency to strike outwards at this point owing to a curve in the river bank just above the head-race entrance.

The water in the head race will freeze over completely in winter; and, as is well known, no frazil will form under the ice; but, should any commence running before the ice forms, the racks are so hinged and arranged that they can be lowered to the bottom, or taken out completely, allowing it to run through the wheels. The crib piers and booms are so arranged that there will be no danger of the ice shoving down onto and destroying the racks. The greater part of whatever ice forms in the head race will go over the overflow dam and the small balance will go through the waste weirs without trouble.

Construction of False Dams.

Work was commenced in the fall of 1895 by throwing out a false dam (Figs. 2, 3 and 4) of stone and earth at right angles to the shore; then by running a short wing dam down stream, enough of the river bed was made bare (Fig. 5) to enable the contractors to get sufficient stone by excavation to grade to continue the dam further out into the river and to commence running a wing dam down to the site of the main dam, on which are the wheel houses. Every foot added to the wing dam

FIG. 3.—VIEW OF FIRST FALSE DAM OF THE LACHINE RAPIDS POWER PLANT AT THE POINT WHERE IT TURNS DOWN STREAM.

FIG. 4.—VIEW OF THE FIRST FALSE DAM FROM THE DOWN STREAM SIDE.

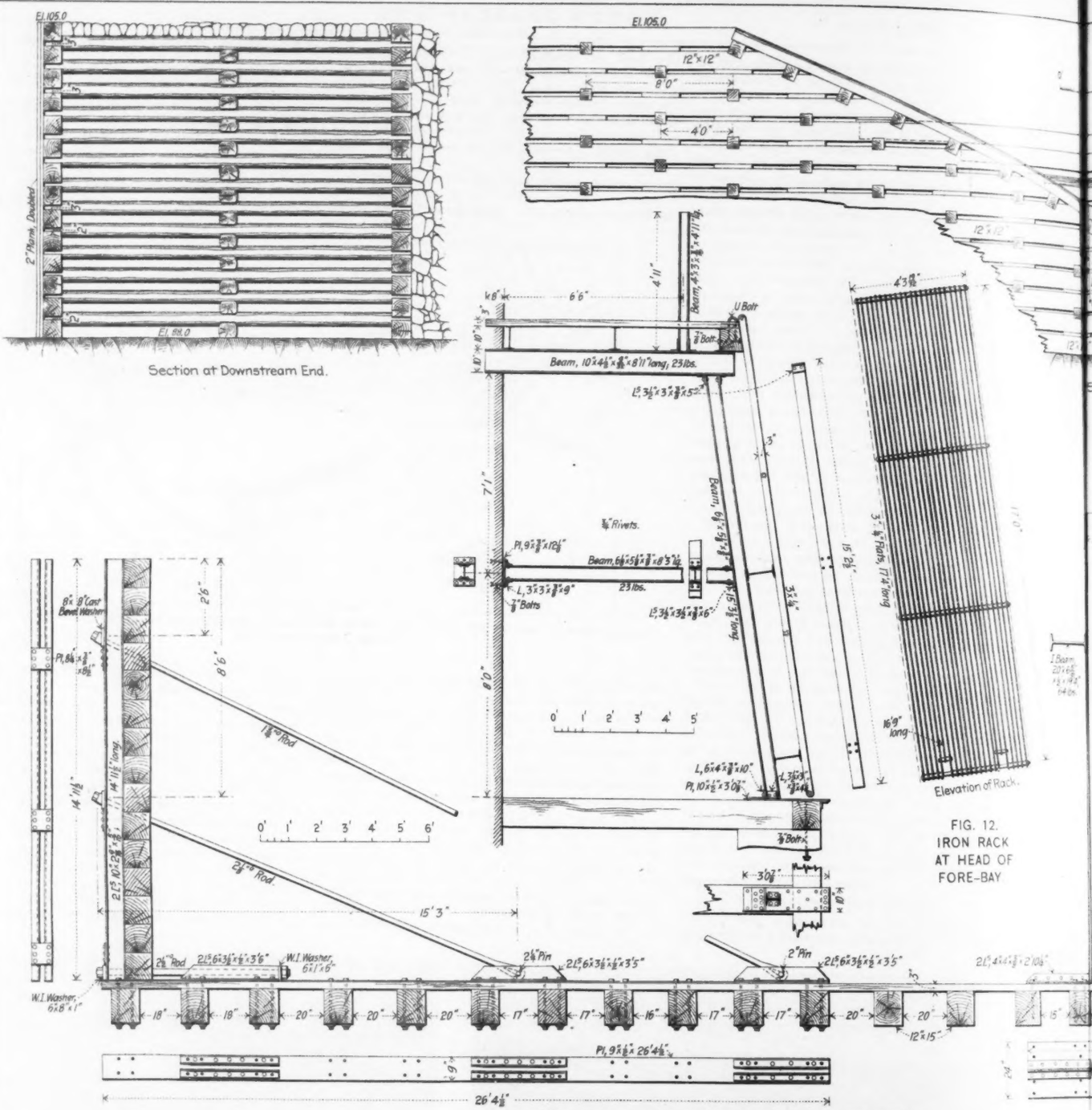


FIG. 12. IRON RACK AT HEAD OF FORE-BAY

FIG. 11. DETAILS OF FLUMES SHOWING STOP LOGS AND STAYS.

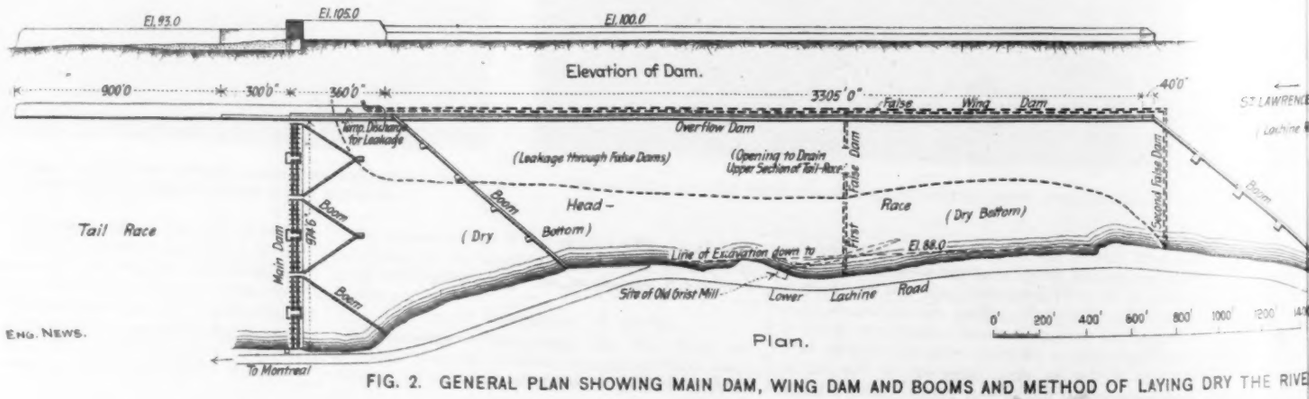


FIG. 2. GENERAL PLAN SHOWING MAIN DAM, WING DAM AND BOOMS AND METHOD OF LAYING DRY THE RIVER

WATER POWER PLANT AT THE LA

T. Pringle & Son, and W. McLea Walbank, Montreal, Can., E

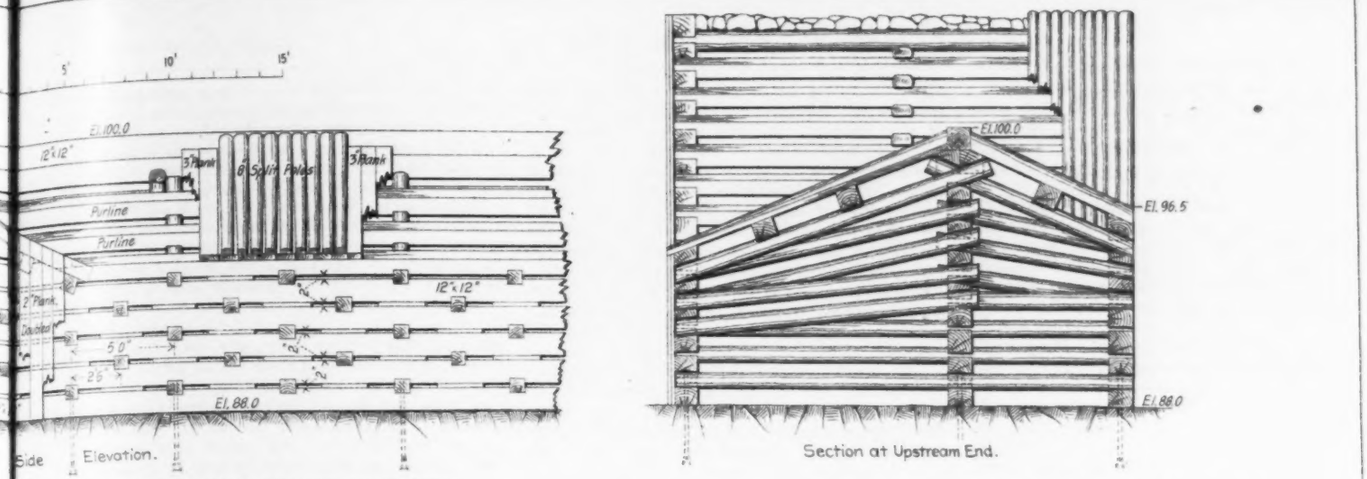


FIG. 6. CRIBWORK OF WING DAM AND GUARD PIER.

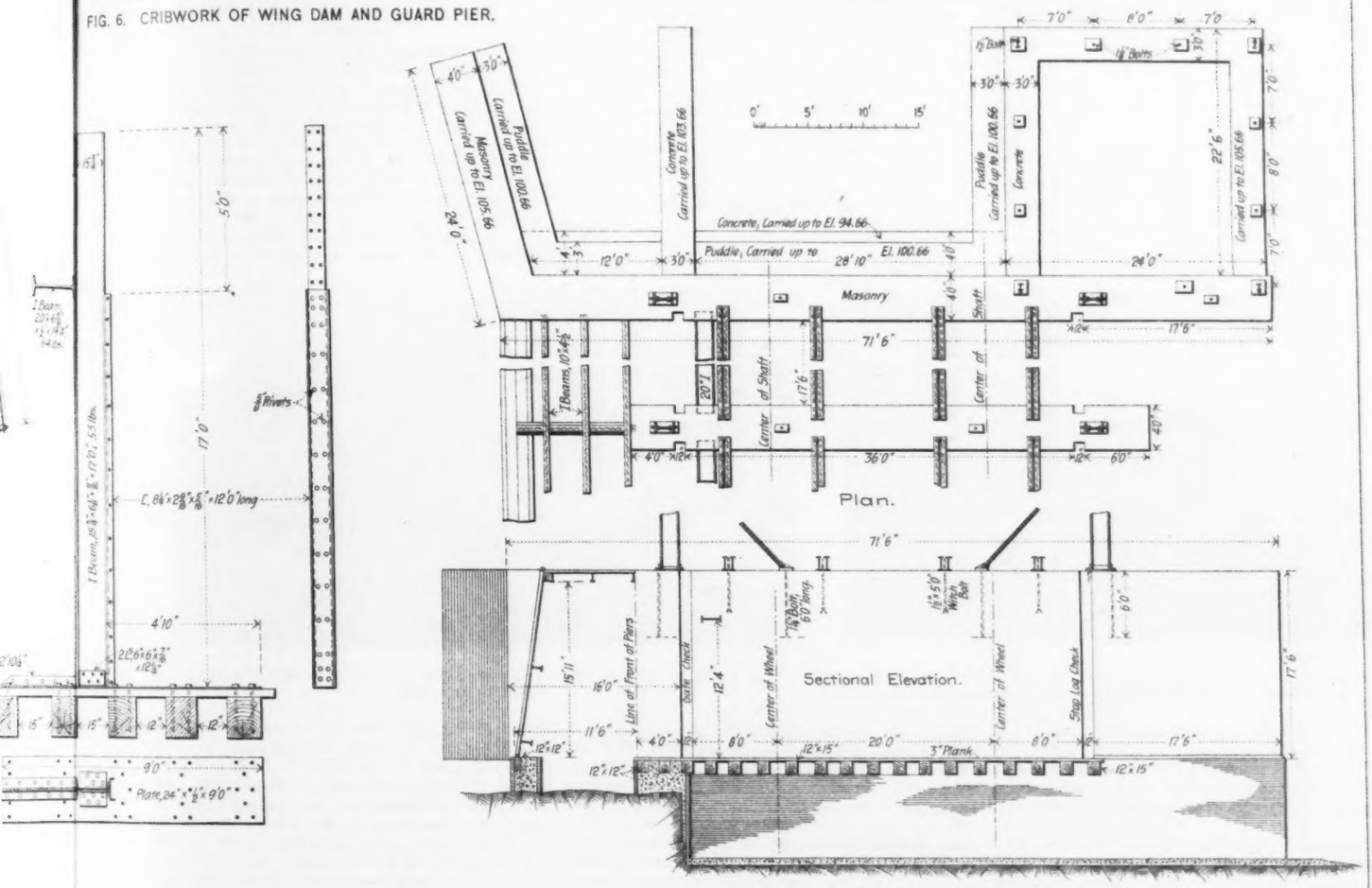


FIG 15. DETAILS OF SHORE ABUTMENT OF MAIN DAM.

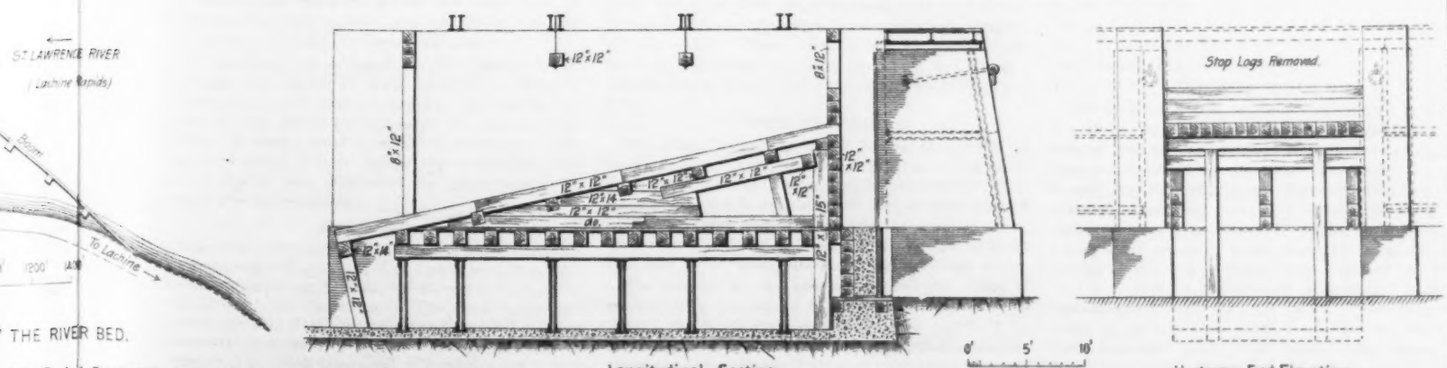


FIG. 10. DETAILS OF A WASTE WEIR IN MAIN DAM.

THE LACHINE RAPIDS, MONTREAL, CAN.

al, Can., Engineers. Wm. Davis & Sons, Ottawa, Ont., Contractors.

CHAS. HART & SONS, LITH., 30 VESEY ST., N. Y.

downstream, laid more of the river bed bare and allowed excavation to be made down to grade. This work was carried on during most of the winter by means of steam drills, and the rock taken out was used to construct another dam (Fig. 2) at right angles to the shore, 150 ft. above the extreme upper end of the proposed wing dams. These two false dams were connected during the past season, and when they were sufficiently advanced an opening was made in the lower dam and the water in the upper portion drained out, enabling the whole of the work to be done on a comparatively dry river bed.

Much trouble was experienced in building these dams, owing to the raging current which at several places swept away 75% of the material, consisting of large boulders, etc., as fast as it was dumped in. The fact of their having been built of such large stones has also given the dams a tendency to leak badly in spite of banking with earth mixed with pea-straw, etc.

Cribwork.

The cribwork dams were then commenced. These consist of, first, a high crib 360 ft. long (Fig. 6) built of 12 × 12-in. face timbers laid to 2-in. joints with 8-in. flatted ties laid 8 ft. apart in each course and 8-in. longitudinals; and, second, 3,305 ft. of overflow crib with 12 × 12-in. longitudinals and purlines. The top is hipped up with an easy slope on the shore side and covered with 2-in. plank and 8-in. tamarac split poles with the bark on. The slope on the side towards the river is steeper and is covered with 8-in. tamarac squared on three sides and laid on purlines.

FIG. 8.—VIEW OF THE RIVER BED LAID DRY BY THE CONSTRUCTION OF THE FIRST FALSE DAM.

The vertical face of the whole dam on the shore side is sheeted with two layers of 2-in. plank and an ample talus of gravel is laid along the shore side. Both cribs are filled with carefully placed stone of moderate size and are scribed and bolted to the rock when above the grade adopted for the bottom of the head race, 12 ft. below the top of the main dam. Below this it is considered that the stone filling is ample security and the cribwork is merely scribed to fit closely to the rock. The wing dam cribwork above the main dam is 20 ft. wide at the bottom and the cross ties are run entirely through wherever possible.

The masonry ice breaker at the upper end of the wing dam is 40 ft. long, and 20 ft. wide; it is built on a concrete foundation two-thirds the depth of the water (which is 21 ft. deep at this point), of rough bush-hammered masonry. The top is bevelled to 5 ft. below the water line and 2½-in. chains are embedded in the concrete to fasten the upper boom.

Main Dam.

The main dam piers (Fig. 7) are built of rough bush-hammered masonry 4 ft. thick, laid on a concrete foundation 4 ft. 6 ins. thick, which runs up to the level of the flume floor. The rock under the wheel pits was first excavated and levelled off, and owing to its shaly and unreliable nature a layer of concrete 1 ft. thick composed of 2 parts sand, 1 part Portland cement and 6 parts stone (these proportions were used throughout the work), was laid over it, holes being left to receive the columns supporting the flume bottoms. Caissons (Fig. 8) of 2 × 4-in. stuff, laid on the flat and well tied through were then run up to the level of the underside of the timbers supporting the flume floor. These timbers of 12 × 15-in. pine were then laid, running back 15 ins. into the concrete and were bevelled off so as not to weaken the foundation.

The caissons were brought up to the level of the flume floor and filled with concrete. Two longitudinals of 10 × 12-in. British Columbia fir were run under the floor timbers and 15 ins. into the caissons along the front of the flume. These are each supported by six 6-in. I-beam columns placed in holes in the wheel pit bottom above mentioned, which were then flushed up. Masonry was then laid on this foundation to a height of 17 ft. above the flume floor. This masonry is of a very high class character, the blocks being extremely large and averaging about 2 ft. in thickness; they are laid in cement mortar, composed of 2 parts of sand to 1 of cement.

Two recesses, 12 × 8 ins., 36 ft. apart, are provided for the gates and stop logs, the downstream one being 6 ft. from the back of the piers and the upstream one being 4 ft. from the front of the piers. The piers are 4 ft. thick by 48 ft. long, 21 ft. 6 ins. c. to c. for both flumes and waste weirs.

Power Houses (Fig. 9).

The power house walls are built in a similar manner and contain between them massive concrete foundations for the generators. The walls are 4 ft. thick along the front and sides to the line of the downstream end of the piers; beyond this the masonry is only 3 ft. thick and 3 ft. high, with a 16-in. brick wall up to the top of the piers.

FIG. 7.—VIEW OF LOWER SIDE OF MAIN DAM, SHOWING THE CAISSONS SURROUNDING THE CONCRETE FOUNDATIONS FOR THE MASONRY PIERS.

The generator foundations are constructed in the form of heavy columns with arches between, and afford every facility for getting at the holding down bolts of the generators.

Vacant spaces between and behind the foundations are filled with stone flushed over with 8 ins. of concrete up to the same level as the flume floors or tail water. These spaces will be utilized for heating apparatus, storage, etc., and will be accessible by a spiral staircase and a hatchway 4 × 5 ft.

Shore Abutment.

The shore abutment (Fig. 15) is also built of masonry 4 ft. thick, and from the line of the rack runs into the bank in a sloping direction. This sloping portion is backed with 3 ft. of clay puddle up to the frost line, 4 ft. below the ground level. There is also a wing wall 12 ft. behind this of concrete, 3 ft. thick, running 23 ft. into the bank.

The portion of the abutment next the flume is backed with concrete 4 ft. thick, running up 6 ft. above the flume floor and with clay puddle 3 ft. thick above this up to the frost line. These precautions are taken to preclude any possibility of leakage around the back of the abutments.

A cribwork embankment is carried along the shore from the corner of the abutment to a point about 50 ft. upstream. All ties in this crib are kept so that the ends will be below the frost line.

Waste Weirs (Fig. 10.)

The floor timbers and flooring for the waste weirs are finished in the same way as the flumes; 12 × 12-in. stop logs are laid in the upstream check, and the upper four of these can be taken out and replaced to suit the level of the head water. A heavy timber slide is built over the floor for ice, etc.

Arrangements were made to drain the water through the waste weirs under the flooring during construction. This was done by omitting the concrete wall along the front from the rock bottom up, and by placing slides into which one set of 12 × 12 stop logs and one set of 2 × 4 stop logs will be dropped and the space between filled with concrete, when the construction is completed.

Head Gates.

Each flume is provided with a set of two head gates of pine, 5 ins. thick, for a height of 5 ft., and 4 ins. thick above, with an iron sliding filling gate in each and two 8 × 4-in. uprights with a cross piece between fitted with wrought-iron shackle to raise the gates by. The head gates move in slides fitted into the check in the masonry and fastened to an upright in the centre of the flume consisting of a 15-in. I-beam and an 8-in. channel into which a strip of wood is fitted, and to this the distance piece between the two gates is screwed. This upright is braced just at the water line by a 20-in. I-beam running across the flume and 11 ins. into the wall on each side; it is securely fastened at the bottom to an iron plate 9 ft. long, 2 ft. wide and ½-in. thick, rag-spiked to the floor timbers.

The gates are intended to be raised and lowered by a traveling crane and will probably be taken out and stored under water after the wheels commence running, as they would obstruct the light if left in position. The space between the top of the gates and the flooring of the building is filled with 3-in. plank laid in the check and bolted to the upright behind the gates.

Stop Logs.

The stop logs (Fig. 11) are 12 × 12 ins., laid into 8 × 12-in. recesses in the piers and braced by two sets of iron eye bolts, three in each brace, running diagonally down to the flume floor and pin-connected to the angle-iron fastenings which are riveted to an iron plate 9 × ½-in. × 26 ft. 4 ins. bolted to the floor timbers. These bolts run out to a bevel casting, bearing on the channel iron uprights and are provided with a nut at the outer end and can be removed if necessary. The uprights are formed of two 10-in. channels placed back to back with a space for bolts between, and held together with cross plates just under the bevel castings. These braces are so placed as to take all strain off the masonry piers.

Rack and Bridge.

The rack and bridge framing rests on 12 × 12-in. timbers running lengthwise of the main dam and 11 ft. 6 ins. from the front of the piers, well supported by 12 × 12 uprights; a butting piece is placed at each pier and braced where necessary by 3-in. plank.

This framing is laid level with the flume floor and is omitted in front of the waste weirs. The rack and bridge rest on steel frame-work constructed of 6-in. I-beam uprights, 12-in. I-beams running lengthwise between piers to support the racks, while 10-in. I-beams are under the bridge floor which is about 6 ft. wide. The outer one of the bridge beams is faced with a 10-in. timber against which the rack rests. The rack (Fig. 12) is made of 3 × ¼-in. bars, 17 ft. long, laid to 2¼-in. centres in sections 4 ft. 3½ ins. wide, well bolted through and with thimbles between each bar. Each section is supported on two castings (Fig. 13) so shaped that the rack may be swung over so as to lay on the head race bottom (which will be levelled off in readiness) or it can be easily taken out and replaced without the necessity of sending down a diver to unfasten the bolts.

The rack is constructed in this manner so that it may be taken out of the way in order to pass frazil through the wheels in case the frazil should begin running before ice forms over the head race. If the rack were permanently secured in the ordinary way the frazil would adhere to the rack bars and impede the flow of the water.

The bridge beams are floored over with 2-in. plank, and a rail is carried along the bridge about 2 ft. from the edge, giving ample room for a man to rake the rack.

Booms.

The system of booms (Fig. 2) is as follows: (1) At the entrance to the head race on a very easy rake will be placed a boom 1,340 ft. long, constructed in the form of a Howe truss, the chords being three 12 × 12-in. timbers, the main braces 3-in. plank and the counterbraces 4 × 12-in. timbers.

The 3-in. plank is laid solid on the top and bottom and between the 12 × 12-in. timbers and the 4 × 12-in. timbers are placed on edge between the layers of plank. The whole is securely spiked and bolted every 8 ft. with three bolts, one through each 12 × 12-in. timber, the bolt diameters varying from 1¼ in. to 1¾ in. This boom is in sections 250 ft. long with a clear span of 220 ft. and is 14 ft. wide and 4 ft. deep. Its details are illustrated in Fig. 16. It will be securely fastened to the shore and the ice-breaker and will be supported by four crib piers, 30 ft. square, constructed of 12 × 12-in. timbers and filled with stone.

These cribs are made large, as they stand in about 25 ft. of water. (2) At the lower end of the overflow dam will be placed a boom 1,000 ft. long, constructed of three 12 × 12-in. timbers, fastened with 1¼-in. chains and 1¼-in. bolts. This boom will be secured to a timber sunk into the ground at the shore end and will rest against a buttress on the overflow dam. It will be supported by four crib piers 13 × 22 ft., the fronts of which are at a slight angle to the sides, so as to obstruct the flow as little as possible. (3) At a distance of 250 ft. from the front of the main dam are placed two piers, 13 × 22 ft., with ice-breaking faces and constructed of 12 × 12-in. timbers.

Booms constructed of two 12 × 12 timbers with bolt and chain fastenings are secured to these and inclined to the waste weir entrance, forming a complete protection against any trash which may be allowed to pass the second boom (if the water level ever falls below the top of the overflow), and against ice which may form in the head race up to the second boom. All the boom piers are provided with suitable snubbing posts capped with galvanized iron and are filled with stone.

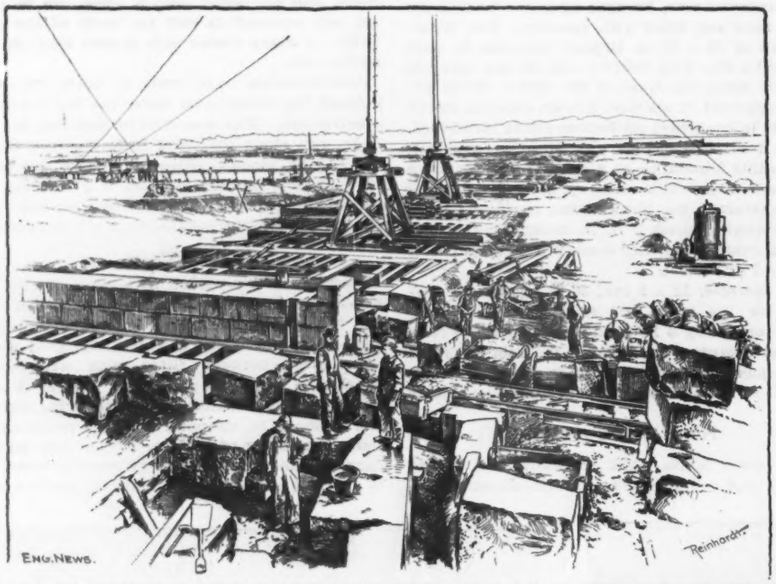


FIG. 8.—VIEW OF MAIN DAM SHOWING TIMBERING FOR FLUME BOTTOMS AND BEGINNING OF MASONRY PIERS.

Turbines.

Each flume will contain (Fig. 9) two special 54-in. Victor turbines, a total of 72, which are connected in sets of six turbines to twelve generators, four in each power house. These wheels are set vertically on 3-in. plank flooring, and will develop 200 HP. each, under a 11-ft. head, a total of 14,400 HP. Under this head they will run at 64 revolutions per minute and discharge 12,000 cu. ft. of water per minute.

Each set of six wheels is connected by bevel core gears to a common jack-shaft and this transmits their power at a speed of 175 revolutions per minute to a 3-phase generator of 750 K-W. guaranteed to stand 25% overload. The speed is regulated by a governor guaranteed to control the speed within 2% from no load to full load.

The gears and shaftings are supported on heavy cast-iron saddles resting on 15-in. I-beam girders, two beams to a girder, bolted at the ends to the piers by bolts running 24 ins. into the piers. These girders also support by stirrups 8-in. I-beams on which the gear shed flooring of 3-in. plank lies. This flooring is so arranged that the stop logs may be taken out and hatches are hinged over the space required to take out the head gates. At the back and front of the gear shed beyond the ends of the 8-in. floor beams the flooring rests on 12-in. timbers.

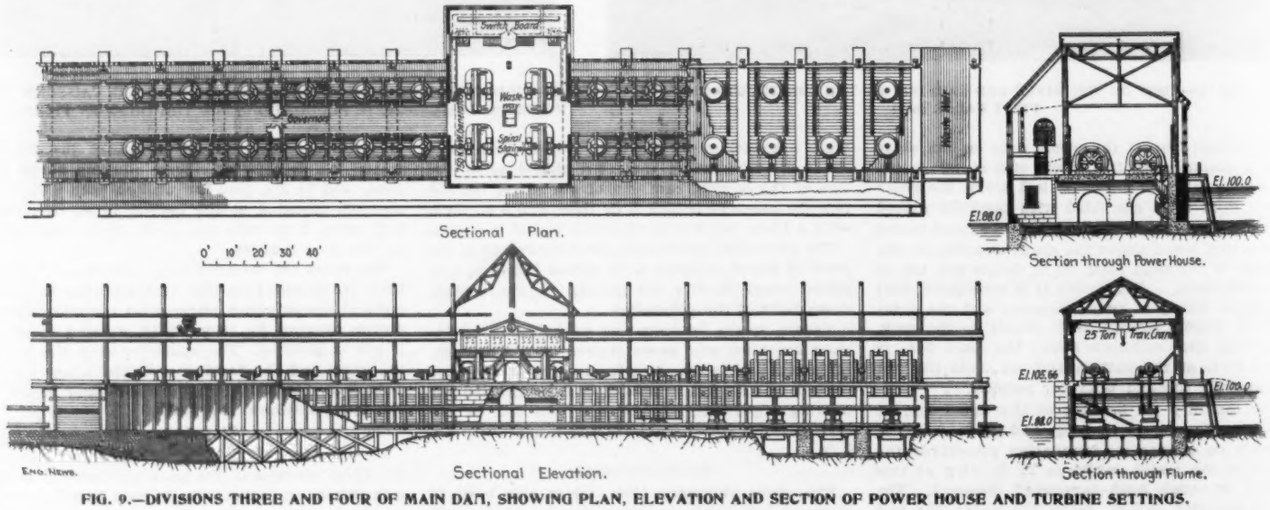


FIG. 9.—DIVISIONS THREE AND FOUR OF MAIN DAM, SHOWING PLAN, ELEVATION AND SECTION OF POWER HOUSE AND TURBINE SETTINGS.

Gear Sheds.

The gear sheds (Fig. 14) are of steel frame with peak roof, Fink truss design. The uprights at each pier are lattice columns and are arranged to carry 21-in. I-beams on which a 25-ton hand power crane will run from end to end of the building, a distance of 975 ft. The distance from the floor to the eaves of the shed is 25 ft., to the peak 36 ft.,

and the distance between uprights, or the clear width of the shed inside, is 38 ft. A wooden sheathing of studding and planking will be run along the sides and covered with corrugated iron. Between the roof trusses, which are 21 ft. 6 ins. apart, 6 ×1 2-in. purlines will be laid. Over these two layers of 1¼-in. boards will be laid, with two-ply 10-oz. roofing felt between, and the whole will be covered with four-ply plastic asphalt.

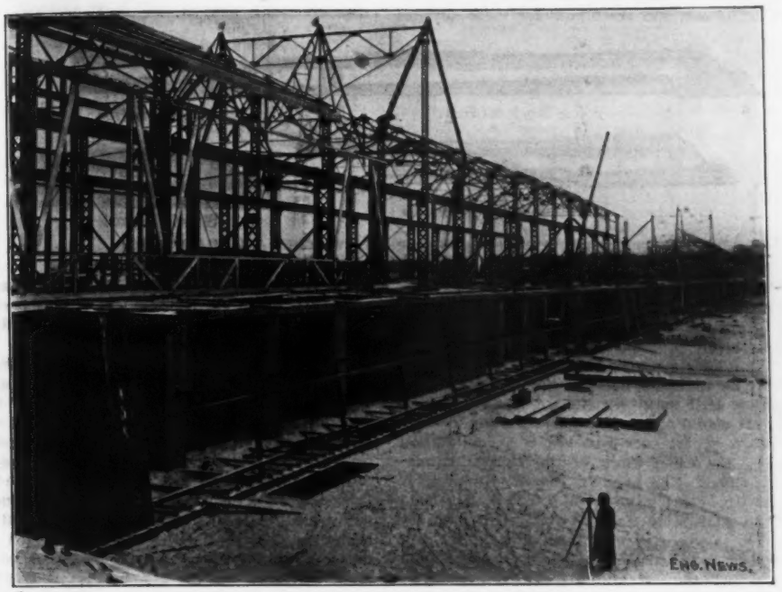


FIG. 14.—VIEW OF THE FRAMEWORK OF THE GEAR SHEDS AND POWER HOUSES OF THE LACHINE RAPIDS POWER PLANT.

Dominion Bridge Co., Montreal, Can., Contractors.

Power Houses.

The power houses (Figs. 9 and 14) are built of steel frame and the roof is of special design, the distance to the peak being 50 ft.; 12-in. brick walls are carried all around the front, back and sides, except where the traveling crane passes through, above which a wooden partition will be run up with doors to close when the crane is not in use. Loads carried by the crane will pass through openings 12 ft. wide on each side. The inside dimensions of the power houses are 64 × 44 ft. The flooring is of concrete covered with 1-in. rock asphalt to prevent dust rising from the concrete.

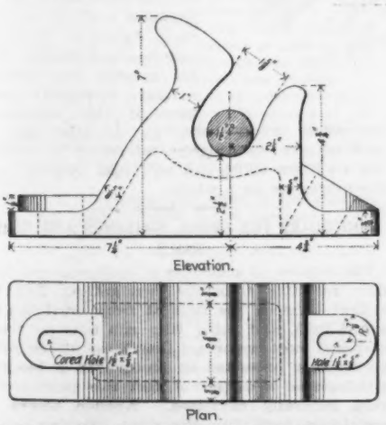


Fig. 13.—Castings Forming Hinge Support of Rack for Protecting the Turbines of the Lachine Rapids Power Plant.

The generator foundations form the flooring as far back as they go; beyond them, 12-in. I-beams are laid with terra cotta between, over which 3 ins. of concrete is laid. The flooring is given a pitch of ¼-in. to the foot for drainage. A hatchway 4 × 5 ft., and a spiral stairway is provided for access to the vault-like recess below the generators and pipes to carry the cables to the switchboard, etc., run through the floor.

On the massive arched foundations are to be placed the generators; these will stand 11 ft. high above the floor, have a base 15½ × 10 ft., and weigh about 45 tons each. They are held down by four 2¼-in. bolts 12 ft. long, which can be readily taken out if required. Two stone blocks, 30 × 24 ins. × 16 ft., are placed under the generators, one at each side. Two 4-pole exciters of 75 K-W. capacity are placed at the downstream end of the power house. They are belted to the main shaft and will each serve two generators, but either of them is capable of exciting four generators. The bases of the exciters are securely bolted down to the I-beams on which they rest.

Switchboard.

The switchboard arrangements are not yet completed, but they will probably stand on an elevated structure at the downstream end of the power houses; they will be built entirely of marble and finished to an ornamental design.

Power will be transmitted to the distributing station in Montreal, a distance of six miles at a pressure of 4,400 volts. This will be carried by 36 No. 0 copper wires strung on double petticoated insulators on six cross arms. The poles are of lattice steel work set 6 ft. into concrete and are placed 100 ft. apart. From this station the power will be distributed throughout the city in underground conduits.

The capital stock of the Lachine Rapids & Hydraulic Land Co. is $2,000,000. The officers of the company are: President, G. B. Burland; Vice-President, T. Pringle; Managing Director, W. McLea Walbank; Directors, E. Kirk Green, Peter Lyall and S. Carsley, of Montreal, and Alexander Fraser, of Ottawa. The engineers of the work are Messrs. T. Pringle & Son, and W. McLea Walbank, of Montreal, and Dr. Cary T. Hutchinson, Postal Telegraph Bldg., New York city, is in charge of the electrical department of the work. The contractors for excavation, masonry and cribwork were Wm. Davis & Sons, Ottawa; for turbines, shafting, gears, etc., the Stillwell-Bierce & Smith-Vaile Co., Dayton, O.; for electric machinery, the Canadian General Electric Co., Peterborough, Ont.; and for steel construction and pole line, the Dominion Bridge Co., Montreal.

There have been used in the work 8,700 cu. yds. of concrete, 6,000 cu. yds. of masonry and 2,900,000 ft. B. M. of timber; 225,000 cu. yds. of rock have been excavated.

The writer wishes to acknowledge his indebtedness to Messrs. T. Pringle & Son, from whom the detail drawings used in the preparation of this article were obtained.

EXPERIENCES WITH THE CONTRACT SYSTEM OF U. S. LAND SURVEYS IN FLORIDA.

By J. Francis Le Baron, M. Am. Soc. C. E.

The following remarks are offered as the result of twenty years' experience in land surveys in Florida:

Most of the surveys of the public domains in this state were made between 1830 and 1855, and the ordinary surveyor's compass was the only instrument employed, as the solar compass and solar transit had not then been invented, or, at least, had not been sufficiently developed to be used in practice.

The instructions issued to the U. S. Deputy Surveyors, in these early days, were generally in manuscript form and were arranged to suit the individual ideas of the Surveyor General then in office. And it should be remembered that then, as now, these Surveyor Generals were neither practical nor professional surveyors. The General Manual of Surveying Instructions was not issued by the U. S. General Land Office until Feb. 22, 1855. This manual was the guide until May 3, 1881, when a new and much more full and explicit manual was issued.

As a consequence of the old system we find some peculiar and conflicting instructions emanating from different Surveyor Generals, and it is on record that one Surveyor General of that time issued imperative orders to all his deputies to use a variation of 6° 10′ in running all lines, without regard to the actual magnetic variation at the time. A report of the U. S. Coast Survey also states that the land surveys of Florida were being made by the United States on the magnetic course without allowance for variation. The Spanish surveys, however, were made in a similiar manner. As the result of my own experience it can be said that there is probably no state in the Union where the public surveys are in a worse condition than in Florida.

The causes for this bad work are apparent. It is a notorious fact that contracts for surveying

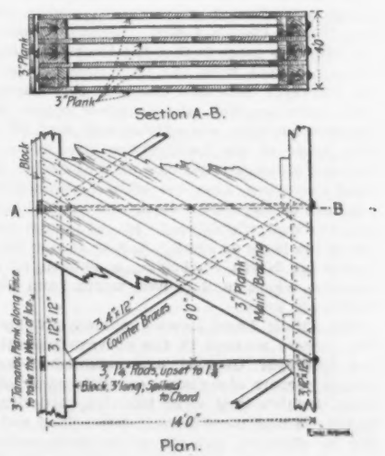


Fig. 16.—Howe Truss Forming Boom across Entrance to Head Race.

have been given to second-rate surveyors, or to persons who have never been known as surveyors before appointment. These appointments were usually political, without reference to fitness or previous technical service or occupation, and negro slaves or other unskilled persons were too generally employed as chainmen and axemen. The

results of this inefficient and ignorant work are very evident in the surveys handed down to the present generation of engineers, and these results are now especially annoying and costly, as the value of land increases with the gain in population.

Sec. 90 of the Public Land Laws provides that "the Surveyor General shall occasionally inspect the surveying operations while in progress in the field, or deputize a confidential agent to do so." This duty is now performed in a perfunctory manner; but in the early days of the public survey in Florida there is good reason to believe that the law in this respect was scarcely observed at all. One of the late Surveyor Generals of Florida, Mr. Martin, in his report for 1881, says there is only one record in his office of any such examination, and he further says that there are at least five townships in the state, reported as surveyed and subdivided, in which there are no posts, corners or marked trees, and in which the actual topography is entirely different from that shown on maps and in field notes. The evidence is that the surveys were never made and the whole report was a fraud.

In my own experience, while making a survey for a canal, in 1885, from Tampa to Punta Rasa, I found a township situated on the west shore of Lemon Bay, in which there were three rivers from 900 to 1,300 ft. wide emptying into the bay. The map of the township showed only dry land, without a sign of a river or creek; nor did the map of the adjoining township show signs of either. Still, I found section corners and blazed section lines leading directly across these streams. On Indian River I found that the range line between Range 37 and 38 East did not match within one-quarter mile where this line crosses the river. Near Cedar Keys, in Levy and Marion Counties, the township lines do not join within over one-half mile and the range lines by 1¼ miles. The surveys on the Caloosahatchee River do not join within ¼ mile and one row of sections is only ¾ mile wide, and one township is 7 miles wide, where the record calls for six miles.

This too common error in the dimensions of sections, supposed to be exactly 1 mile square, is a source of great confusion to railway engineers, who are frequently strangers, unfamiliar with the methods of land surveys and who take it for granted that every section is 1 mile square. As a result I have frequently noted that their maps are distorted and incorrect; made so by drawing on their own maps section lines assumed to be exactly 1 mile apart. This occurred on one of the railways running into Jacksonville, to the great confusion of the maps of location filed in the County Clerk's Office. Another reason for the blunders made is that the township maps are often procured from the Land Office instead of the Surveyor General's Office, as they should be. The latter are full and complete copies of the original surveys, are official and cost $3 each. The maps of the Land Office give areas only, without distances, and cost only $1 each. Young land surveyors, also, too often assume the correctness of old section lines and lay out quarter subdivisions, which may be as much as one chain too large or small. A case of this kind occurred at North Burbridge, a suburb of Jacksonville, where land is now worth from $600 to $1,000 per acre.

The Public Land Laws explicitly provide that the corners marked in the surveys returned by the Surveyor General are established as the proper corners of sections, or subdivisions of sections, "which they were intended to designate." It follows that these corners must stand and cannot be changed, and the courts have uniformly held that in any public survey "the original field notes returned by the Government Surveyor should be the main guide, and these should be supplemented by the official description of the survey, but both of these should yield to the official plot on record." The General Land Office also holds that the field notes of the surveys may be resorted to to restore obliterated lines and corners. These same rules apply to the private grants and claims segregated from the public domain and surveyed by the U. S. Deputy Surveyors. These grants in Florida are even more confused, if possible, than the public land surveys, especially in the case of the old Spanish grants.

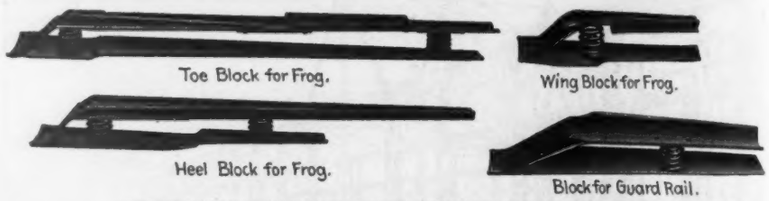
The causes for the inaccuracy of many of the old surveys is to be found in the crude instruments employed, the undeveloped state of the art of surveying, the ignorance of the surveyors and the fact that at the time many of them were made such surveys were considered useless and as simply a waste of money by the national government. The ordinary price paid for these surveys was only $4 per mile for section lines and $6 for township lines. The present prices are for section lines in open land, $5 per mile, and in dense undergrowth, $7. For township lines the price is $7 and $9, and for meander lines $9 to $11 per mile.

So far as the later surveys are concerned, the manual of 1881 may be criticised in a number of ways. It would appear that it is not the production of an expert surveyor, but is a compilation made by the Chief Clerk of the Land Commissioner's Office. The result is that it is impossible to honestly comply with the instructions laid down, in Florida at least, at the prices paid for the work. Long experience has shown that with a properly equipped and trained party of 6 men and a cook, teamster and wagon, 6 miles a day on a township line in pine woods, and from 1 to 2 miles in hammock, or swamp, represent an average of honest work. Compare the cost of the outfit and subsistence in a remote region with the official return for this work and you will find that receipts will rarely meet expenditures.

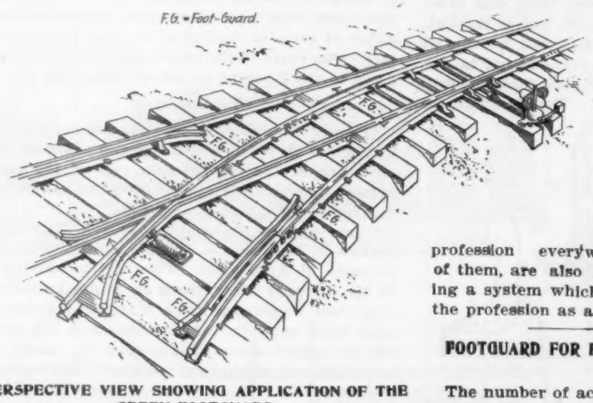
The present instructions require the use of a solar compass or solar transit. But on diligent inquiry, I have yet to find that either were ever employed on a survey in the state. I am also informed by a former attache of the U. S. Surveyor General's Office that no meridian is established at Tallahassee for testing instruments, and that there are no instruments there. Further, the Surveyor General himself is not a surveyor, and is thus incompetent to test instruments, as the law requires him to do. He is a lawyer of great ability and a most efficient executive officer, but he is not, and has never claimed to be, a professional surveyor or an engineer. No standard chains have ever been issued to deputies, and I cannot discover that any examination has ever been made of their instruments or chains. This was certainly never done in my own case. I have provided myself with a standard steel tape for government work and have tested my chain every morning, as directed, but I find no record of this being done in any of the field notes of other surveyors that I have seen.

As to the cost of making surveys in South Florida, Capt. H. S. Duval, the President of the Southern Society of Civil Engineers, has expressed himself very fully. In his report of a survey made in the Everglades in 1881, he speaks of the utter impossibility of making correct surveys at the contract price, and says that it cost him $5 per mile to complete his contract without allowing anything for his own time. As bearing further upon this subject, Mr. C. F. Hopkins, U. S. Deputy Surveyor, says that in certain surveys made by him in the Everglades, hominy cost him $18 per barrel in camp, or six times the ordinary price, and other supplies in proportion.

It is too late now to attempt to remedy the evil done by these old surveys, and we must accept them as we find them and make the best of them. They can only be held up as a warning and a sad example of a pernicious system. But it may be profitable to compare them with the surveys of later years and those now being made. The truth is that a deputy surveyor should be an educated man, well trained in his profession. But few such men can be found willing to stretch their moral sense to the extent of taking a government contract, for the reason that it is utterly impossible to honestly comply with the requirements of the law and at the same time make a living out of the contract. The only remedy seems to be the employment of salaried surveyors on the basis of the staff of the U. S. Coast Survey. The faithful fulfilment of the law also demands that the Surveyor Generals should be trained and expert surveyors and not mere political favorites, selected for services to the party in power. While my own experience applies chiefly to Florida, I understand that the condition of the public land surveys is almost, if not quite, as bad in other states where the contract system prevails. Considering the importance of the results involved, the legal entanglements followed bad work, and the injustice of making individuals pay for blunders made by government sanction, the whole case is one eminently fitted for prompt governmental action. Reputable members of the engineering profession everywhere, in societies and out of them, are also highly interested in reforming a system which can only cast discredit upon the profession as a whole.



THE GREEN FOOTGUARD FOR FROGS, SWITCHES AND GUARD RAILS.



PERSPECTIVE VIEW SHOWING APPLICATION OF THE GREEN FOOTGUARD.

FOOTGUARD FOR FROGS, SWITCHES AND GUARD RAILS.

The number of accidents to trainmen and yardmen, resulting from the men getting their feet caught between the rails at frogs, switches and guard rails, and being then run over by trains, makes it most important that these places should be properly protected by footguards or blocking, although as a matter of fact this protection is very generally neglected. Wooden blocks are sometimes used, but the most effective protection is afforded by the use of some form of metal footguard.

We show herewith a new metal footguard, known as the Green footguard, which is constructed from steel plates in such a way as to fit any angle or shape of frog, switch or guard rail. Each guard consists of two steel plates, one over the other, fastened together at the heel so as to block the entrance, and also to exclude snow and ice, while the plates are held apart by coiled springs of 300 lbs. resistance. Two springs are used for

the longer footguards, and one is used for the shorter guards. The sides of the upper plate fit against the rail heads, and the springs allow this plate to give if struck by a flange on a worn wheel. These guards are manufactured by Roberts, Throp & Co., of Three Rivers, Mich. Those which have been put in use are said to be giving excellent satisfaction.

STEAM ENGINE GOVERNORS.*

By Frank H. Ball, M. Am. Soc. M. E., Plainfield, N. J.

Among all the varied forms of governors which have from time to time made their appearance, none have survived for any extended period which did not utilize centrifugal force as a prominent actuating force.

The resistance of fluids as a substitute for centrifugal force is one of the systems which have been "weighed in the balance and found wanting."

Another interesting theory which was exploited in connection with shaft governors, but never passed beyond the theoretical stage, is the substitution of the resistance of the load, or the pull of the belt for centrifugal force in controlling the steam supply.

A modification of this dynamometrical device appeared in 1883, in which it was combined with a powerful centrifugal governor and made to act in conjunction with centrifugal force, and remarkable results were thus obtained, which, in some respects, have never been surpassed.

Simpler devices have since been developed in which centrifugal force is supplemented by other accelerating forces, commonly called "inertia," and the more complicated dynamometrical construction has been superseded; but it must ever be considered the first important step toward the modern refinement of performance.

Recent activity in this field of engineering has been in the direction of the recognition and utilization of accelerating forces other than that known as centrifugal force. An early attempt in this direction is found in the Patent Office records for 1875 in the work of Mr. A. Kendall.

The Kendall construction is illustrated in Fig. 1, in which A is the governor frame, fixed to the shaft B. Mounted loosely on this shaft is the so-called "inertia wheel" C, which by means of links is connected to the centrifugally acting weights D, the latter being pivoted to the governor frame and wheel and at E. The acceleration of this wheel resulting from a change of speed of rotation, develops a force which acts on the weights D. This construction never came largely into use, because the application of the principle was mechanically crude and clumsy, and the refinements sought to be obtained were lost in excessive friction.

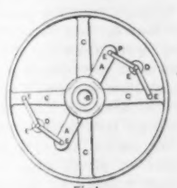


Fig. 1.

Fig. 1.—Diagram of Kendall Governor, 1875.

For nearly twenty years after this work of Kendall no practical results seem to have been accomplished in the use of this accelerating force, and it is only within the last three or four years that Prof. R. C. Carpenter, Mr. J. Begtrup, Mr. F. M. Rites, and others have developed practical devices for utilizing accelerating forces which are extensively used. A paper on this subject presented to this Society at the New York meeting of 1892, by Mr. F. M. Rites, is perhaps the first publication in which the several accelerating forces are analyzed and classified.

It is the object of the present paper to investigate these accelerating forces from a practical standpoint with the hope of stimulating general discussion by the Society. A clear understanding of the subject can best be given by illustrating each of the forces and agreeing as to what we shall call it.

Let Fig. 2 represent a governor wheel or disk fixed on a shaft S, with which it rotates. Let M represent a mass pivoted at P by a connecting arm. The rotation of the wheel in either direction will cause the mass M to move outward.

Referring to Fig. 3, let the same mass M be considered as pivoted on the shaft by a connecting arm, and free to revolve around the shaft. Centrifugal force in this case is directly resisted by the pivot, and therefore produces no motion of the mass about the pivot. Any change in the rate of rotation of the wheel, however, will not be participated in by the mass M without a force developed in the direction of the arrows, because of the inertia of the mass M, and this force we will call tangential accelerating force, which corresponds with what Mr. Rites has called "tangential inertia."

Assuming the mass M to be concentrated at its centre of gravity and the arm to have no weight, then in Fig. 3 the only accelerating force capable of producing motion of this mass around the pivot is what we have called tangential accelerating force.

Fig. 4 is supposed to represent the same wheel shown in Figs. 2 and 3, with a mass M equal to the mass M in Figs. 2 and 3 and pivoted as in Fig. 3; but the mass, instead of being concentrated at its centre of gravity, is assumed to be distributed in the form of a bar as shown, with its centre of gravity remaining as in Fig. 3. This construction, like Fig. 3, carries the centrifugal force on the pivot without producing rotation about it, and, like Fig. 3, tangential accelerating force is a prominent force to produce pivotal rotation.

Another accelerating force appears in the construction of Fig. 4, to which Mr. Rites has called special attention in his paper referred to, and which he calls "angular inertia," but which is perhaps better described by the term angular accelerating force, because inertia does not seem to be an appropriate name for a force.

The magnitude of this force depends on the distribution of the mass M with relation to its centre of gravity. Under the assumed condition of this mass M in Figs. 2 and 3 no angular acceleration appears, but in Fig. 4 it becomes a pronounced force, and may be described as the effect of the angular acceleration of the mass about its own centre of gravity.

To make this perfectly clear refer to Figs. 5, 6 and 7. Each of these figures is assumed to represent the same wheel shown in Fig. 4, and the same mass M pivoted as in Fig. 4.

Rotation of the wheel and mass M in the direction indicated would result in the successive positions of the mass M that are shown, and it will be seen that, while rotating around the shaft S it also rotates around its centre of gravity.

To illustrate this further, suppose the bar or mass M is pivoted at its centre of gravity G. Rotation of the wheel and mass may now take place without rotation of the mass around its centre of gravity.

From the foregoing it is clear that three accelerating forces are available as actuating forces in a governor. The most important, because of its being absolutely indispensable, is centrifugal accelerating force, or centrifugal force. Either or both of the other two may be utilized as governing forces, or they may be inoperative, or may actively oppose the governing motion, and thus become an obstruction. To assist in governing, they must act with centrifugal force during an increase of the rate of rotation, and oppose centrifugal force when rotation is decreased.

The three accelerating forces we have been considering may each be developed by a separate moving part, or all three may appear in a single moving part. The latter plan is looked upon with most favor because of its simplicity and fewness of parts.

A study of these forces with regard to their practical utility and possible limitations of usefulness is best made by first investigating them separately, and then as a combined force developed from a single moving part.

Beginning with centrifugal force as the one always present in every form of governor, the radial distance from the centre of gravity of the moving part to the centre of rotation determines the amount of force developed at any given speed of rotation with a given mass.

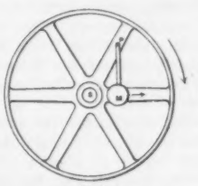


Fig. 2.

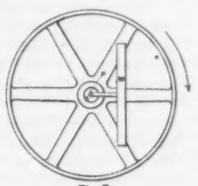


Fig. 5.

Fig. 3.

Fig. 6.

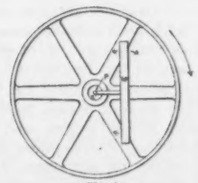


Fig. 4.

Fig. 7.

Figs. 2, 3 and 4.—Diagrams Illustrating Action of Tangential Accelerating Force.

Figs. 5, 6 and 7.—Diagrams Illustrating Action of Angular Accelerating Force.

Looking at this feature alone it would seem desirable to locate the centrifugally acting mass as far from the centre of rotation as possible, so as to reduce the mass and the consequent gravity disturbance to a minimum. The question of centrifugal force, however, and particularly the problem of initial tension of the springs, present practically insurmountable difficulties that limit the radius of the centre of gravity of the centrifugally acting mass to a comparatively short one.

The relation of the initial tension of governor springs to the initial radius of the swinging centrifugal mass is now well understood by engineers conversant with the art.

It is well known that what is called isochronism is only possible when the centripetally acting springs are adjusted to full theoretical initial tension; or, in other words, when the distance of initial stretch of the springs corresponds to the initial radius of the centrifugally acting weight or mass. For the purpose of this paper it is sufficient to say, that even where an approximation to theoretical tension is used the spring problem is made very difficult, unless the initial position of the centrifugally acting mass is comparatively near the centre of rotation.

The author then discusses at some length the effect of tangential accelerating force, and reaches the following conclusion in regard to it.

It is evident that tangential accelerating force is a desirable governing force only when the outward path of the swinging mass falls rapidly back from the radial line. When so arranged, however, the length of the arm on which centrifuugal force acts to produce a turning moment around the pivot is rapidly changed by the swinging of the mass, and as it shortens with the outward motion the problem of initial tension of the springs is made very difficult, and in fact almost impracticable of application. It is very questionable, therefore, whether tangential accelerating force is a practical force in the ordinary forms of governor construction, and particularly so where one end of the spring is fastened to a stationary part of the rotating wheel.

If two symmetrically swinging weights are used and their centres of gravity are connected by a spring, the force is not transmitted through the pivot, but being carried directly by the spring no centrifugal arm need be considered, and this difficulty is then not encountered.

Leaving now the consideration of tangential accelerating force, and taking up the investigation of angular accelerating force, we do not find any conflicting forces that limit its usefulness. It may therefore be advantageously introduced into the governor problem to any extent consistent with constructional limitations.

If the reasoning of the foregoing pages is correct, the following conclusions must be accepted:

1. Centrifugal force is the most important governing force, because it is indispensable.

2. Angular accelerating force is next in importance, because it is an unqualified help as an actuating force, and its practical usefulness is limited only by constructional considerations.

3. Tangential accelerating force is of questionable utility, because of the disturbing forces that it is almost sure to put into operation.

*Abstract of a paper presented at the New York meeting of the American Society of Mechanical Engineers.

A DIRECT-COUPLED GAS-ENGINE AND DYNAMO.

The Baylis Company, successor to the Gallaher-Baylis Engineering Co., 97 Cedar St., New York, is introducing a combination of a Nash gas engine and a dynamo. The shafts of the engine and dynamo are in line, and are coupled together by a friction clutch. An interesting feature of the combination is that the clutch is operated by a shaft governor placed in a flywheel on the shaft of the dynamo, so that when the dynamo begins to run over its normal speed, it is for an instant disconnected until the governor on the engine, which regulates the gas supply, can operate to bring the engine to the proper speed, when the clutch is again thrown into gear. By this means it is claimed the speed of the dynamo can be so controlled that it will furnish a steady current for incandescent lighting. The particular advantage of the combination is great compactness as compared with a belt-connected engine and dynamo. With gas at $1.25 per 1,000 cu. ft., it is claimed that the gas engine will furnish power for 2¼ cts. per HP. hour, and that the combination will bring the cost of lighting by arc lamps of 1,000 c. p. to 3 cts. per lamp hour, and by incandescent lamps of 16 c. p. to ¼ ct. per lamp per hour. The Nash gas engine is manufactured by the National Meter Co., 298 Broadway, N. Y. It is of the vertical type, with the usual four-stage cycle, and is made in the single cylinder form from ½ to 10 HP., and with double cylinders from 10 HP. upwards. Two engines of 200 HP. each are now under construction. They are to be operated by producer gas, and will be direct connected to dynamos for electrical work. The coal consumption is expected to be 1 lb. or less per I. HP. per hour.

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Published every Thursday at Tribune Building, New York. Entered at the Post Office, New York, as Second Class Matter.

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ALFRED E. KORNFELD, New York..... } ADVERTISING
F. A. PECKHAM, Chicago..... } REPRESENTATIVES.

PUBLICATION OFFICE.....Tribune Building, New York.
CHICAGO OFFICE.....1636 The Monadnock.

LONDON AGENCY: { SAMPSON, LOW, MARSTON & CO. (Limited), St. Dunstan's House, Fetter Lane.

SUBSCRIPTION RATES: United States, Canada and Mexico, One Year, $5.00; 6 months, $2.50; 2 months, $1.00; Single copies, 15 cents. To all other countries in the Postal Union: Regular Edition, One Year, $7.60, (31 shillings); Thin Paper Edition. One Year, $6.31 (26 shillings). Mailing addresses may be changed at will by sending both old and new address. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay. The number on the address label of each paper indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year; for instance, the number 326 means that subscription is paid to the 32d week (that is the issue of Aug 6) of the year 1896; the change of these figures is the only receipt sent, unless by special request.

ADVERTISING RATES: 20 cents per line agate measure. Want notices, special rates, see page 22. Rates for standing advertisements sent on request. Changes to standing advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon.

In discussing the Deep Waterways Commission's report in our issue of last week, the substance of our contention was that the project ought to be investigated as a project before attacking the question of the most desirable route. We are glad to be able to state that this very thing is now being done. Maj. Thos. W. Symons, of the Corps of Engineers, has been instructed to make "a preliminary examination" of the deep waterway project, and investigate the need for such a transportation route and its economic advantages, or disadvantages if constructed. He has already spent several months in this work, and has as assistants, Messrs. Wm. Pierson Judson and Emile Low, both Members of the American Society of Civil Engineers. We know of no case where a systematic and exhaustive investigation and comparison of the relative economic advantages of ship canals, steamer canals, barge canals, and railways as freight transportation routes has ever been undertaken, and the results of Major Symons' study of this question will be awaited with much interest.

The report of the Board of Expert Engineers approving the project to run the Brooklyn elevated and electric cars across the present Brooklyn bridge is one on which all parties concerned deserve to be heartily congratulated, and this includes the engineers of the Brooklyn railways who co-operated with the Board of Experts, and especially the residents of Brooklyn, who are the ones who will receive the chief benefit from the good work of these engineers. We give on another page the substance of the report, and drawings showing the proposed arrangement of the terminals, and we commend it to our readers as an excellent example of the study and solution of an engineering problem which has attracted a vast amount of attention from the profession generally for more than a decade.

Briefly summarized, the report sets forth and approves a plan by which the Brooklyn elevated trains will make connections with the bridge railway tracks and will for the present be sandwiched between the bridge trains, using one track of the gantleted pair. The electric surface cars will cross the bridge by a single track on each of the vehicle roadways and at the New York terminal there will be an elevated loop and a number of sidings for loading and unloading passengers.

We pointed out some months ago the enormous advantage which will result to Brooklyn from this great improvement and need not comment again upon it now, further than to say that the enlargement of the traffic facilities which will result from giving both elevated and surface cars through passage across the bridge will doubtless make transit for bridge passengers expeditious and comfortable even in the rush hours for some years to come. In fact it is likely that the carrying out of these plans will result in the abandonment, for the present at least, of the plans recently canvassed for a tunnel under the East River near the line of the bridge and terminating at Ann St. and Broadway in New York city. This tunnel was backed by the electric surface railways of Brooklyn, and if they secure passage across the bridge, as now seems probable, they will not be disposed to risk their money in a tunnel. But the projected tunnel farther south, which is to land suburban passengers of the Long Island R. R. at Cortlandt St., may still be undertaken.

The plans submitted by the experts appear to receive almost unanimous approval from the press of both New York and Brooklyn. There has been a little senseless talk about the danger of running elevated trains across the bridge, but even a layman can appreciate on what a slim basis this criticism rests when he understands that the number of trains will be no greater than the number of the present bridge trains, when operated on the new gantleted system, and the weight of the elevated cars is considerably less than the weight of the bridge cars. The weight of the elevated railway locomotives is probably no greater than that of the bridge switching locomotives, which always run across the bridge when the cable is idle; and as a matter of fact the locomotives do not enter into the problem at all, for the elevated cars are to be equipped with electric motors like the bridge cars, and electric traction is to be used on the entire Brooklyn system,—another great gain for the people of Brooklyn, and for the elevated railway stockholders.

The question of the compensation which the railway companies shall pay for the use of the bridge is still to be considered. Manifestly they should pay enough so that the income of the bridge will be sufficient to pay its expenses, including maintenance and the interest on its cost. It is to be borne in mind, however, that under the new arrangement it should be possible to reduce the operating expenses of the bridge to a mere trifle of what they now are. The payroll and salary account alone of the bridge amounted to $720,000 in 1895. The police force alone numbers 90. When the new through-traffic arrangements are in full operation, however, the need of a large police force to handle the crowds during the rush hours of morning and evening will be largely obviated. The electric switching will effect another large saving; for under the old system it cost much more to switch the cars at the terminals than to haul them by cable across the bridge. Further, the ultimate outcome of the proposed change will doubtless be the entire withdrawal of the bridge trains proper. With both elevated and surface cars running across the bridge, there will be very few to take the cars at the Brooklyn terminus, and they can be accommodated by these trains better than by the present bridge trains.

The operating expenses of the bridge will then be reduced to the maintenance and policing of the structure and the operation of the cable plant, with such supervision of the train movements as may be necessary for safety. It ought to be possible therefore to so reduce expenses that the Brooklyn railways can be given the desired facilities at a rental so low that they need not charge an additional fare for transit across the bridge.

"A phenomenal task" in bridge shifting is described and illustrated in a late issue of "The Engineer," of London. The Great Eastern Railway Co. replaced an iron-girder bridge of 77 ft. span and weighing 100 tons, by another of 84 ft. 9 ins. span, weighing 130 tons, in 13½ hours from the commencement of the operation. The new structure had been erected on falseworks alongside the old bridge and was mounted upon trucks. The first work done in shifting trusses was to lift the old bridge 18 ins. and place under it trucks similar to those under the other. The two trusses were hauled along together until the new bridge occupied the site of the old one; the new bridge was then lifted by a huge traveling crane, the trucks were removed and the trusses were lowered into place. A gang of 60 men was employed.

The time in which this work was accomplished may be considered phenomenally short in England, but American bridge builders can do better. During February, 1896, the Chicago & Northwestern Ry. Co., at the crossing of the Wisconsin River, at Merrimac, Wis., replaced 12 riveted deck spans by the same number of plate-girder deck spans, without interfering with traffic. The girder spans were 49 ft. between centers of towers and not so deep as the old spans, so that the towers had to be raised. The new girders were erected on falsework alongside the old, and as soon as the track was cut and the ties removed, the old span was slid bodily onto falseworks provided and the new girder was slid into its place. The first operation consumed 3 minutes, and the second 5 minutes; the old bridge being moved 14 ft. and the new one 15 ft. From the time of cutting the rails to the resumption of traffic, the time occupied in moving the 12 spans averaged less than 1½ hours for each.

Last year the Cleveland, Akron & Columbus Ry. Co. also replaced some old Howe truss bridges by modern steel structures. The new bridge over Big Walnut Creek had a span of 91 ft., crossed by two plate-girders 9 ft. deep. These were riveted up complete in the shops and placed on cars. Gallows-frames were erected at each end of the bridge; and when the traffic was stopped, the girders were suspended to these frames; the top laterals and cross bracing of the Howe truss were then removed and the girders were lowered on the seats provided for them between the trusses of the old bridge. The operation consumed about 5 hours in all. In 1887 the Pennsylvania Ry. Co., in 15 minutes moved the Conestoga iron truss bridge, 349 ft. long, 60 ft. above the water, and weighing 450 tons, a lateral distance of 45 ft. onto new trestlework. The old bridge was to be replaced by stone arches and the traffic was carried on the old structure in its shifted position until this was completed. The whole bridge was moved the 45 ft. in 15 minutes after the track was cut; and in 80 minutes the first train was run over the bridge in its new position.

Steel rails have been sold during the past week at prices lower than have ever before been recorded in this country. We announced last week the collapse of the pool which has for so many years been maintained. The low prices which followed were at once taken advantage of by most of the large railway companies, and according to reports, enormous purchases of rails have been made by a number of the principal companies. Prices are said to have been made as low as $17 and $18 at Chicago, and the Carnegie Steel Co. is even said to have offered to take contracts for $14.50 per ton at their works, which almost halves the price that ruled up to a few days ago. The reduction in price will probably have some effect in stimulating railway construction, but it will have a greater effect in inducing railway companies to expend money in improving track by replacing worn and light rails with rails of modern heavy section. As is well known, for nearly four years most of the railway companies have confined their expenditure for rail renewals to their absolute necessities, and only the wealthiest have been able to keep up the work of introducing rails of heavy section in place of the old light sections. The opportunity to make up for this enforced economy has been eagerly taken advantage of. There is good reason to believe that the setting at work of all the rail mills will have a most salutary effect on business in general.

The lowest prices on record for cast-iron water pipe, so far as we recall, were bid on a recent contract in New York city. The price was $16.10 per ton for 2,095 tons of pipe from 6 ins. to 36 ins. in diameter, delivered at the New York city

pipe yard and was bid by the Warren Foundry & Machine Co. As showing the severe competition in this line it may be noted that two of the three other bidders were below $17.

CONCERNING THE CONTRACT SYSTEM FOR PUBLIC LAND SURVEYS.

The system of awarding to the lowest bidder the important work of surveying the public domain of the United States has many times been shown to be absurd and objectionable, but it nevertheless still continues in force. This method of treating professional work, which demands not only training and experience, but faithful and conscientious work, has given rise to fraud and gross error in the past, and its continuance is a serious reflection upon the intelligence of the officials in charge of the General Land Office.

The contract system of making surveys was inaugurated at a very early period in the history of the United States; when the public lands were of so little value that any money spent upon their survey was practically regarded as wasted, and when the art of land surveying was undeveloped and the instruments employed in it were of the crudest description. At that time engineering as a profession was practically non-existent. There were no trained government engineers, and hence this work was of necessity handed over to such local surveyors as were then in practice; and the contract system was taken as the best available for compensating them. Some of these old-fashioned surveyors did very intelligent and honest work; remarkable work when we consider the state of the art of surveying at that day and the class of instruments they had to depend upon. An example of such conscientious work is the surveying of the parallel separating Pennsylvania from Maryland by Charles Mason and Jeremiah Dixon in 1763-67. This so-called Mason and Dixon's Line has been tested by the best modern methods and with the latest and most improved instruments, and it is found to be correct in all important points. But these two men were distinguished English mathematicians and astronomers; were sent from England for this special purpose, and were of a very different type from the class of surveyors then in the American colonies. Washington himself was a surveyor of public lands in his day; and from the specimens of his professional work still existing he was a painstaking and honest worker, exceedingly methodical and neat in his plats and field notes.

The surveys made at this early period were generally confined to comparatively limited areas; and though blunders were common enough, arising from crude methods and inefficient tools, the general results were usually correct, and the surveyor conscientiously performed his work to the best of his ability and training. At that time there was no serious objection to the contract system of payment for services, because it was the only one generally available. The trouble arises from the continuance of this system, from about 1830 to the present time; from the contract survey of great areas in the new states, with the temptation to secure work by low bids and the inevitable interjection of politics into the appointment of the surveyors without regard to their fitness and training.

The present system of the survey of public lands is older than our present government. It was inaugurated by a committee of the Continental Congress in 1784, with Thomas Jefferson as its chairman. This committee, and its immediate successors, fixed the present 6-mile square township, with its subdivision into one mile square sections; and while the first surveys were made under the Geographer of the United States, Congress, on May 18, 1796, provided for the appointment of a Surveyor General; and in 1812 the General Land Office was established, with a Commissioner at its head, who was placed in general charge, under the Treasury Department of all pertaining to the survey, patenting, etc., of the public lands of the United States. In 1849, when the Department of the Interior was established, the General Land Office was transferred to the new department, where it still remains.

It was not until 1855 that any attempt was made to officially regulate the surveys of public lands by the issue of a manual of instructions to State Surveyor Generals and their deputies. This first manual was compiled by John M. Moore, the Principal Clerk of Surveys at that time. This manual, revised and greatly extended, is still in use; and while the honest fulfillment of the many requirements there laid down would insure good and accurate results, the method of payment still in force practically makes these requirements invalid and impossible, for the reason that faithful performance would generally result in pecuniary loss to the surveyor. The present manual of instructions demands that the surveyor shall be educated and experienced in his profession; that he shall use costly instruments and shall accurately and permanently mark his survey on the ground by blazed trees, posts, mounds, etc. He must provide himself with an efficient staff, and with the means of subsistence in wild and unexplored land and must convey these supplies from place to place. He goes out as a pioneer, with little or no means of knowing beforehand the local and engineering difficulties he has to encounter and how long it may take him and his party to overcome them and to faithfully perform the many duties intrusted to him.

To suppose that any man, even the most experienced, can at all times fix the exact cost of doing this work "per mile of line run," before he knows anything of the detail topography of the country he is to run through, is to suppose an absolute absurdity. He must guess at this cost, and if he understands expenses, as he is not unlikely to do in his desire to be the lowest bidder, then either the individual or the government has to suffer loss—and under average present conditions and fixed contract prices, it is not usually the individual. We say this with all due regard for the integrity of the better class of deputy surveyors, and for their sense of moral obligation to their oaths of office. But the surveyor is not performing this work for his health; he is dependent upon the proceeds for his professional income. He may adhere strictly to the letter of the law, but he will certainly not feel it incumbent on him to do more than he is obliged to do to have his work accepted and paid for.

On the other hand, if the surveyor is not an experienced engineer, but is a man appointed purely as a reward for political services, as is unfortunately too often the case, then the public interest is bound to suffer. The contract price in such a case simply represents a figure from which the surveyor will deduct all he can for his own personal profit, regardless of the requirements of the survey, and the instructions laid down in the manual. If he were only ignorant of his duty as a surveyor, the loss might come merely from inaccurate work and from the confusion and litigation which this inevitably causes. But if he be dishonest as well as ignorant, then we may have some of the instances referred to by Mr. Le Baron in his article in the present issue on the public land surveys of Florida, where the maps and field-notes for whole townships are pure fabrications, without any survey as a basis.

From any point of view it seems inexpedient, wasteful and contrary to the best interests of the public to first fix a price "per mile" upon works of this important character and then to seek the lowest bidder to perform this work. The honest man is compelled in many cases to take chances which he should not be called upon to take, and it often happens that the upset price is so low that experienced men will not enter into competition because they know that the work cannot be honestly done for the figure fixed. In such a case the work usually falls to the lot of the young and inexperienced or to the man who takes the contract to make money—honestly if he can, but otherwise if he must.

The mischief which has been done in the past by the frauds and errors of the public land surveys it is now too late to remedy. Their fruit has been the expenditure of many millions of dollars in wearisome and profitless litigation and the embarrassment of enterprise in countless cases, through uncertainty as to land titles.

But while nothing can be done to rectify the errors of the past, it is not yet too late to learn wisdom from experience and to see to it that such parts of public domain as are still unsurveyed shall be surveyed on some system which will make possible its subdivision in an accurate and scientific manner.

The contract system of land surveys has been tried for a century and found wanting. It is an excellent illustration of the folly of letting to the lowest bidder a class of work which requires a good degree of professional ability and a sense of professional honor on the part of the worker, and which from the nature of the case cannot be inspected and tested by superior officers.

The government knows of better methods of carrying on professional work of this class. It has in its coast and geodetic survey an organization that is a model the world over for the scientific accuracy and the absolute faithfulness of its work. Had the surveys of the public lands been carried on by a permanent staff of engineers organized on lines similar to those of the Coast Survey, the expenditure on land surveys would have doubtless been somewhat greater, but for every penny thus expended a dollar would have been saved to the people in the litigation over property boundaries that has resulted from past practice.

While a comparatively small part of the public domain still remains to be surveyed, it is certainly worth while to see to it that the work that remains shall be well done.

It would be a step in the right direction if Congress should require the head of the Land Office and every State Surveyor General to be a competent and experienced surveyor; and if Congress does not act, it is nevertheless within the power of the Executive Department to effect this reform by selecting competent men for these offices instead of making the offices the reward for political services.

LETTERS TO THE EDITOR.

West Bluff Sewer System, Peoria, Ill.

Sir: I desire to call your attention to an error which appeared in the article on the West Bluff Sewerage System, of Peoria, Ill., published in Engineering News of Jan. 28. The error appeared on the two-page engraving where the titles of Figs. 3 and 4 were exchanged. Fig. 4 shows the original form of the combination manhole and flush tank. I desire to thank you for the excellent manner in which the matter was presented. Yours truly,

A. D. Thompson, City Engineer, Peoria, Ill.

Peoria, Ill., Feb. 2, 1897.

Sir: We notice in Engineering News of Jan. 28 the full and elaborate report of the sewer system put in at Peoria, Ill. The article is presented in very nice shape and gives a very satisfactory account of the work which was accomplished. We notice one thing that is missing, however, in this article. That is, that the large amount of sewer pipe required for the construction of this system, which was between 400 and 500 car loads, was furnished by the Monmouth Mining & Mfg. Co., of Monmouth, Ill.

Very truly yours,

Monmouth Mining & Mfg. Co., Monmouth, Ill.

Chicago, Jan. 30, 1897.

Cost of Incandescent Electric Lights in Montclair, N. J.

Sir: Your paper of Dec. 5, 1895, publishes "A Model Electric Lighting Franchise for Montclair, N. J." In it the maximum price for incandescent lamps is fixed at 20 cts. per 1,000 watts. Assuming this means 1,000 watts per hour and that there are 750 watts in a horse power and 3,000 hours in a year, then the cost per year would equal $450 per HP. Would this not be a very high price for incandescent lighting, and should not the clause have read 20 cts. per 5,000 watts per hour to have made the cost of 1 HP. per year $90?

If you will kindly answer these questions and correct above figures (20 cts. per 5,000 watts per hour = $90 per HP. per year) if they are in error, I shall be greatly obliged to you. Yours very truly,

S. T. Haigh, Jr.,
Engr. Fall Brook Railway Co.

Corning, N. Y., Feb. 4, 1897.

(The figures were correct as given, 20 cts. per 1,000 watts, which is equivalent to about $2 per 1,000 ft. for gas. It must be remembered that the cost of distributing the current as well as the cost of generating it must be taken into account.—Ed.)

Checking Multiplication By Excess of Nines.

Sir: It has seemed strange to me that the method of checking multiplication by "the excess of nines" is not more used. It takes little time, is very simple, and absolutely correct. While almost universally known, I have found few engineers who use it. Simply stated, it is this: The excess is simply the remainder left after dividing the

sum of the digits by 9. Rule: Multiply the excess in the multiplicand by the excess in the multiplier, and find excess in the product. If the work is correct it will be the same as the excess in the grand result. Example: $286,547 \times 7,926 = 2,271,171,522$.

The sum of the digits in the multiplicand is 32, and $32 \div 9$ gives 5 as a remainder or excess. Similarly the excess in the multiplier is 6. Then $5 \times 6 = 30$, leaving an excess or remainder of 3, which should also be the excess in the answer, or grand result 2,271,171,522, and this is the case. In practice, in adding the digits we drop 9's or combinations which make 9. Of course, if the sum of the digits is less than 9, take that as the excess.

If there is no excess in either multiplicand or multiplier, there will be none in the result e. g., $72 \times 65 = 4,680$, which has no excess. Yours truly,

A. M. Steger.

206 West Grace St., Richmond, Va., Feb. 4, 1897.

(The method described is, as our correspondent says, a very old one; and is probably known to most of our readers; but its convenience makes it worthy of more general use.—Ed.)

The Experiences of Some Recent Graduates in Engineering.

Sir: Discussions on the value of a collegiate training in engineering will never down. The frequency with which the topic is brought up in the technical journals of the country is startling, because these discussions can come only from two classes of men. They may come from the engineer who has had no collegiate advantage so far as engineering is concerned, but who has found a place in the profession by virtue of his own hard work and his own natural ability for the work. Such a man questions the utility of devoting four years of life to a collegiate training, since these four years are usually the most valuable for getting a footing in the occupation to which one intends to devote one's life. Or, the discussions may come from graduates in engineering who find that a college course is not all that is necessary to make an engineer, or even an embryonic one, and who have depended on their college course to make them engineers instead of upon their own hard work in after life, and are consequently unsuccessful. It is improbable that the successful engineer who is a college man would ever call in question the value of a college course or the wisdom of spending four years in acquiring the rudiments of his profession; nor is it likely that such discussions would be started by college students themselves, since in this country there is no other legitimate way of entering engineering proper save through the medium of a college course.

The writer's attention was drawn to this discussion by the publication of the following circular, issued by the College of Civil Engineering at Cornell:

The College of Civil Engineering of Cornell University was organized a little over 20 years ago. Of the total number of graduates, 28 members have died, or about 7%, thus leaving 358 alumni now in the world. These have been classified in the manner indicated above, into nine professional ranks, which show with fair accuracy the relative professional importance of the places reached by our graduates. The following table shows more plainly the probabilities that every hundred men who are graduated from this University College have of belonging to any one of the nine professional ranks for which their education is available:

Professional rank.	Percentage of employment for each rank.
I. Presidents	4.47
II. Chief Engineers, Superintendents and Managers	28.77
III. Professors	10.34
IV. Assistant Chiefs, Resident and Division Engineers	6.98
V. Assistant Engineers	20.11
VI. Draughtsmen	3.92
VII. Allied Professions	14.52
VIII. Miscellaneous	6.15
IX. Not heard from	4.74
Total	100.00

It will be seen that a little over one-half of our graduates are found among the four highest ranks of professional life. Also, that this number is probably larger, by additions from rank VII., which contains about 14% of our alumni, who are as likely to secure satisfactory positions as the members of the highest ranks.

In contrast with the above, an attempt will be made in the following paragraphs to give an idea of the men, their ambitions and their abilities who formed the graduating class of 1895 in the Civil, Mechanical, Electrical and Mining Engineering courses of a western college. An outline will also be given of the work they have done since graduation nearly two years ago.

All the members of the class were ambitious. Many had ambition and no corresponding ability. None realized that success could come only by tediously earning it. Few had any concrete ideas as to what they should attempt after graduation, but all were alike in the belief that in a year after their college course was over they would be able to take a position as chief engineer or general manager. The motives which caused some of them to take up an egineering course were very singular. Thus the most promising of the students in mechanical and steam engineering said: "I always have been a tinkerer; when at home nothing pleased me more than to mend the chicken coop and paint the garden fence, so my people thought that I would make a good mechanical engineer." One student had started in the mining course since his people wanted him "to do something clean and nice." When he found that he had to trudge over the hills several days a week with a geology professor his interest waned. Next year he gave up his mining engineering and took up a course in English nominally in order to get culture, but presumably to get the courtship which is provided with a course in English at co-educational colleges. One very bright student in electrical engineering became completely disheartened because he found that electrical engineering was being given as a course at the Young Men's Christian Association, and that the same professor also gave a course of lectures on the "Theology of the Book of Job." This same student gave up his course entirely when he subsequently learned that a teacher of shorthand and typewriting in a neighboring business college was training electrical engineers, and that he guaranteed that he would make his students as competent engineers with a six months' course as the students would be who graduated from the college course of four years.

It was among those taking the course in civil engineering that the unrest was most perceptible. Several of them felt that the time was unprofitably spent and had frequent talks with the professor. He candidly acknowledged that the financial rewards of engineering were not enticing, that periods of depression affected the engineer most disastrously, and that the profession was swarming with untrained and incompetent men who were satisfied to do its drudgery. "But," said he, "there is no training like that given to students in civil engineering which so eminently fits them for going into any class of work which men may do." The professor would then go on to say how successful some men had been in literature and science, who were trained as engineers, and would name Herbert Spencer, Tyndall, Robert Louis Stevenson and others.

At the end of four years about 35 men were graduated out of the 150 who had started in the four departments of engineering. The graduates in the mechanical engineering course invariably had the perception to see that it was imperative that they should enter machine shops and get a practical training if they were to compete successfully with the hard-headed mechanics who had forced their way to the top in their special fields. They recognized that these men despised and discounted college men until they had been begrimed and had passed through the "overall" period. These fellows all recognized this, and most of them are now serving an apprenticeship to machine shop practice. Their apprenticeship being reduced from four to three years—as their college course of four years was considered an equivalent for one year of shop practice.

Of the mining engineers, two of them have gone into their father's business of making shoes, since no opening could be found for them as mining engineers, save that of pushing a dump car in a mine or holding the drill. The electrical engineers have been lost sight of. One, who in college was the brightest and most all-around fellow, has taken up illustrating in a daily newspaper, and another one who had tried for eighteen months to get something to do finally concluded to give up electrical engineering and go into the "canned fruit" business. Only two of the ten graduates in this course have anything to do. One is with a large "Light & Power Co.," and is doing well; and the other is tending dynamos at the plant of a large street car company, which position he only obtained because he was engaged to the daughter of the general manager. The other eight graduates in electrical engineering say that the 21 graduates of the six months' electrical course given at the business college by a typewriter have obtained all the positions available, namely those of stringing wires in houses, roadmen for the Western Union Telegraph Co., or cleaning arc lamps and changing carbons.

The twelve men from the civil engineering course have all been heard from. It was peculiar that none of them looked forward to railroad work. Most of them had specialized in hydraulics because of the openings afforded hydraulic engineers by the irrigation work of the west. One student only took up railroad work systematically and obtained a position immediately on leaving college, and still retains it, with the pay of a poor carpenter. After two years of fruitless effort to obtain work in other lines two others have followed his example and are in the employ of the same railroad corporation. One of the graduates in hydraulic engineering was able to secure the position of engineer to a scheme of irrigation, but the man in immediate charge of the work and to whom the engineer had to report and from whom he took his instructions was a carpenter without an elementary knowledge of hydraulic work. Three other of the hydraulic engineers are ranching in the valleys of California, and another is rodman on the location of a short line of road.

A paraphrase of a letter given by an official of the engineering department of a railroad to one of the graduates in civil engineering who had applied for a position may indicate the attitude in the far west toward engineering graduates. The letter was addressed to the resident engineer of the maintenance of way department and said in substance:

Place the bearer in one of your carpenter gangs at the first opportunity, and pay him what his services are worth. He is conversant with railroad engineering and you may use him in that capacity at such times as you find it necessary. He is a graduate of the engineering department of —— University.

It is not to be expected that these 35 graduates should have accomplished anything great within 18 months after graduation, but it might at least have been hoped that they would be well started in the line of work to which they wished to devote themselves. Such a beginning as outlined above does not seem to augur so brilliant a record after twenty years as that shown by the graduates of Cornell. It is very improbable that Cornell's record can be duplicated, and it would appear that its men must have been exceptionally fortunate or unusually gifted. The very large number of men to be found in all lines of work who were once civil engineers, or who were trained as such, indicate that other colleges could not show anything like the professional success for its engineering graduates that has been reached by the men from Cornell.

Yours truly,

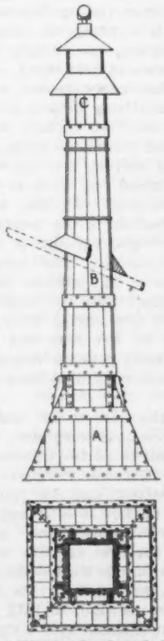
R. L. Donald.

Oakland, Cal., Jan. 2, 1897.

(In comment upon this very readable account of the experience of some recent graduates of "a Western College," we would say that it is not so much the college as the times that make the striking contrast in results referred to. Twenty years ago competent engineers were fewer in number, and the great business activity from 1879 to 1892 provided many opportunities for young engineers. But engineering graduates of many institutions found an entrance to their profession difficult to make two years ago, and the times are not much improved now. For these years we doubt if Cornell can show much better results than the Western college. There is, however, some matter for reflection on the part of young engineers in other portions of this letter. Hard work, coupled with natural ability, will alone ultimately win the prize; and while an engineer may often have to begin with the pay of a poor carpenter, if he has the ability and the energy, he may rise to positions to which he could never have aspired if he had gone to work at the start at the carpenter's trade instead of studying engineering.—Ed.)

WOODEN SMOKEJACK FOR ROUNDHOUSES.

The use of wood for smokestacks seems at first sight to be somewhat of an anomaly, but we illustrate herewith a wooden smokejack for roundhouses, where liability to fire is not great and where the ordinary iron jack is rapidly destroyed by the corrosive action of the gases. The stack is made in three sections; a bottom section (A) tapered to a wide base, an intermediate section (B) tapered slightly, and a small straight top section (C) carrying the chimney-jack. The sections are built separately, of longitudinal staves tied together by hoops, preferably of wood, and when two halves of a section have been built and are ready to be put together their inside surfaces are coated with sand. The sand is applied by first painting the face and then, while the paint is still wet, applying the sand. The combination of paint and sand when subjected to the action of the gases, smoke, and heat passing through the stack is said to become very hard, and to be capable of resisting a high degree of heat. These wooden smokejacks cost much less than those made of iron and are much more durable. The jack has been patented by the inventor, Mr. Charles Pickring, of Richmond, Que., Canada, and it is reported that it is being tried on a number of roads, including the Grand Trunk, the Boston & Maine and the New York, New Haven & Hartford railways.

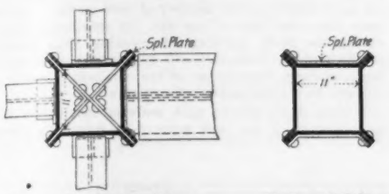


A Wooden Smokejack for Locomotive Roundhouses.

A NEW BOX COLUMN.

The column here described is square, but is made of four trough-like sections of an entirely new shape, not at present rolled by any mill in the country. The disposition of metal is entirely on the outer periphery of the column, thus giving a large radius of gyration and a proportionate amount of strength. The inventors claim as a special advantage, as compared with other wrought iron columns, the fact that the section of the column is of such a nature that the radius of gyration will always remain constant on any axis passing through the center of gravity of the section of any given column.

There are only four lines of rivets, while the ordinary box column has eight, and the Phoenix column, except in the smaller sizes, also has eight.



Section of Column made up with Fillers and Pintle Splice Plates.

Section of Column without Fillers and with Splice Plates on the Sides.

A New Box Column. Designed by W. B. Goddard, Jr., and E. O. Cox.

It is claimed to possess peculiar facilities for connecting floor-beams, girders, etc., as it has four straight, flat, unobstructed sides, and connections can be made through diagonal flanges by means of pintle plates. A good and efficient splice can be made and the base can be easily arranged to distribute the load over the foundation provided.

The column is the invention of Mr. W. B. Goddard, Jr., and Mr. E. O. Cox, of Philadelphia, Pa. The inventors claim that the column can be made as cheaply as any on the market, as soon as the shapes are made available, and that it will develop 10% more strength for the same amount of metal. They are now compiling a set of tables for columns of this type, varying from 6 ins. to 20 ins. in diameter and from ¼-in. to 1⅛ in. thickness, and are about to conduct a series of tests of the column.

THE PRESENCE OF HYDROGEN, HYDROCARBONS AND NITROGEN PEROXIDE IN BOILER FURNACE GASES.

By R. S. Hale.*

It is often stated that the absence of carbon monoxide in flue gases is a sure proof of the absence of any free hydrogen or hydrocarbons in the gases; the basis of this statement being that oxygen has a greater attraction for hydrogen than it has for carbon, so that if the oxygen has burned all the carbon it must of necessity have burned all the hydrogen also.

That oxygen has greater attraction for hydrogen may be true at low temperatures, but the manufacture of water gas should alone have shown that at high temperatures oxygen unites with carbon rather than with hydrogen. The well-known reaction is $2\ C + H_2O = H_2 + 2\ CO$: here the oxygen leaves the hydrogen and combines with the carbon.

The following collection of data also shows that at temperatures ranging around 600° C. or 1200° F. oxygen will burn carbon before it will hydrogen.

1. Hydrogen begins to unite freely with oxygen at a temperature between 650° C. and 730° C.[1] (1200° to 1340° F.)

2. Methane (CH_4) (75% carbon) begins to unite freely with oxygen somewhere between the same temperatures.[2]

3. Ethane (C_2H_6) (83⅓% carbon) begins to unite freely with oxygen somewhere between 606° and 650° C.[3] (1120° and 1200° F.)

4. Ethylene (C_2H_4) (85 5-7% carbon) begins to unite freely with oxygen somewhere between 606° C. and 650° C.[4] (1120° and 1200° F.)

5. Coke (combustible portion about 97% carbon) unites freely with oxygen at a temperature of about 400° C.[5] (750° F.)

All this goes to show that at temperatures between 400° C. and 730° C. (750° and 1340° F.) oxygen has a greater attraction for carbon than it has for hydrogen. The absence of carbonic oxide from the flue gases cannot therefore be regarded as a proof of the absence of hydrogen or hydrocarbons.

Another statement sometimes made is, that if the sum of the percentages of carbon dioxide and oxygen in the gases by volume is over 19%, then there are probably no combustible gases present. This may be true, and when the sum of carbon dioxide and oxygen is high it is a sign that the percentage of carbonic oxide in the gases is small; but, on the other hand, the fact that the sum of the carbon dioxide and oxygen is high cannot be caused by the absence of hydrogen or hydrocarbons. This may be shown as follows, since the composition of the gases depends on the composition of the coal and of the air. Round numbers are taken in the analyses, but similar results are obtained on actual tests.

Analysis of dry gas.	By volume.	By weight.	Combustible, analysis by weight.		Air, analysis by weight.
CO_2	11%	16.1	4.4% C	C 91	23.2% O_2
			11.7% O		
O	8%	8.5	H 5		76.8% N_2
CO	....	....	O 3		....
N	81%	75.4	N 1		....
	100%	100%	100		100%

Now all the gas was originally either air or coal. The carbon all came from the coal. It brought 1-91 of its weight of nitrogen (see coal analysis) with it, 1-91 of 4.4% is 0.048% or roughly .05%. Subtract this from the nitrogen in the gas and we find that 75.35% by weight of it came from the air.

This 75.35% brought $\frac{23.2}{76.8}$% of oxygen (see air analysis) with it or 22.76% of oxygen. But the gas in chimney showed only 11.7% in the carbon dioxide and 8.5% free oxygen or 20.2% in all. The air therefore brought 22.76. — 20.2 or 2.56% more oxygen to the furnace than is found in the gases. This is because the gas analysis is by dry weight, and some of the missing oxygen went to burn the hydrogen in the coal, forming H_2O, which does not appear in the gas analysis. We may now calculate how much oxygen the hydrogen in the coal would burn.

In 100 parts of the coal are 5 of hydrogen and 3 of oxygen. The 3% oxygen would burn ⅜ or 0.38% of hydrogen, leaving 4.62% free hydrogen. There was 91% carbon in the coal and only 4.4% in the gases, so that 4.62% hydrogen in the coal corresponds to $\frac{4.4}{91} \times 4.62 = 0.22$% of free hydrogen in the gases. But each unit of weight of hydrogen combines with eight units of weight of oxygen, so that 0.22 free hydrogen from the coal burns 1.79 of oxygen from the air. There was, however, 2.56% oxygen missing in the gas analysis, of which we find that the H in the coal accounts for only 1.79%, leaving 0.77% oxygen that has disappeared, besides the oxygen necessary to burn ALL the hydrogen in the coal.

Now let us suppose that the volume analysis of the gas has shown 11% carbon dioxide, 10% oxygen, 0% carbonic oxide and 79% of nitrogen, the sum of the carbon dioxide and the oxygen being now 21%, instead of 19%. There is now practically the same amount of carbon in the gas as before, and this carbon must have brought the same amount of hydrogen as before. There is, however, so much oxygen actually present in the carbon dioxide and oxygen that not enough is left of the oxygen from the air to form H_2O with all the hydrogen from the coal, whereas when the sum of the carbon dioxide and oxygen was 19, enough oxygen was missing to have burned all the hydrogen in the coal and more besides, so that in the second case, when the sum of the carbon dioxide and oxygen was high, some of the hydrogen could not have burned. Therefore, a high value for the sum of the carbon dioxide and oxygen is of itself a sign that some hydrogen must have escaped unburned.

It will be noticed that the first calculation as worked out failed to account for 0.8% of the oxygen that must have entered the furnace, even if we assumed that all the hydrogen was burned. Such a result might in practice be due to an error in the analysis, and at first the writer was disposed to so consider it. Finally, however, when the error continued to appear on the same side every time, he was driven to other hypotheses, and remembering that various oxides of nitrogen are formed, both when exploding gases in a combustion analysis of a gas, and when burning coal in a calorimeter, he could see no positive reason why such compounds should not be found in a boiler furnace gases. Not being a skilled chemist, he was unable to make the test himself, but, with the co-operation of Dr. A. H. Gill, of the Massachusetts Institute of Technology, he passed the gases through decinormal potassium permanganate, measuring the gas volume by a meter. Then, on titrating the permanganate, the results showed an amount of oxides of nitrogen which, when calculated as NO_2, gave 0.506 grams per cubic foot of gas making 1.37% by weight or 0.9% by volume.[6]

Finally, we see that though the presence of the nitrogen peroxide in the gases accounts for the missing oxygen, yet the amounts of carbon dioxide, oxygen and carbonic oxide in the gas can in no case prove the absence of hydrogen or hydrocarbons.

THE REPORT ON THROUGH TRAIN SERVICE ACROSS THE BROOKLYN BRIDGE.

As noted briefly in our last issue, a report has been made by the board of expert engineers appointed to investigate the feasibility of running through trains from the Brooklyn elevated and surface railways over the Brooklyn bridge. We give herewith extracts from the report and drawings showing the plans proposed. Fig. 1 is a plan of the New York terminal for the surface railway tracks, as designed by Mr. J. C. Brackenridge and Mr. D. F. Carver, Engineers of the Brooklyn Heights R. R. Co., on behalf of the several surface railways interested, and shows also the tracks for the elevated and bridge trains, which are practically unchanged. It is proposed, however, to put an additional outside platform for the use of outgoing passengers by the elevated railway trains. Fig. 2 is a plan of the connections of the elevated railways with the bridge tracks at the Brooklyn end. Fig. 3 is a diagram illustrating the division of the present bridge tracks between the elevated and bridge trains. It will be seen that in order to get the most convenient arrangement for switching, there will have to be a crossing of the gantleted tracks, and Fig. 4 is a plan of the switch arrangement proposed by Mr. Geo. B. Cornell, Chief Engineer of the Brooklyn Elevated R. R., to be placed at A, Fig. 3, so as to put the through and local trains upon the proper rails of the gantleted tracks. These switches are on the outgoing track, where trains are just starting, so that there should be no difficulty in obeying the signals. The Board of Experts making this report was made up of Messrs. L. L. Buck, V. G. Bogue and Geo. H. Thomson, all members of the American Society of Civil Engineers. We quote from the report as follows:

Surface Railways.

Tracks.—There are two tracks crossing the bridge, one on the north side of the north roadway and one on the south side of the south roadway. The clearance between the widest cars and the outer trusses is 11 ins. The clear width of each roadway is 18 ft. 9 ins. The width of the widest car is 7 ft. 10 ins., which, with the 11 ins. clearance mentioned, makes 8 ft. 9 ins. in width of each roadway upon which cars run. This leaves 10 ft. of each roadway wholly clear.

The Brooklyn Terminal.—The track at the Brooklyn entrance of each roadway is connected by suit-

*Engineer The Steam Users' Association, 31 Milk St., Boston, Mass.

[1] V. Meyer Chem. Zeit, Vol. XVI., p. 1,808.
[2] (Ibid.)
[3] (Ibid.)
[4] V. Meyer Chem. Zeit., Vol. XVI., p. 1,808.
[5] Ernst. Jour. Prak. Chemie, 1893, 31.
[6] It may be of interest to add that when testing for oxides of nitrogen we also tested for cyanides in the flue gases and found no trace. The experiments for cyanides and oxides of nitrogen were made when burning semi-bituminous coal by hand-firing on an ordinary grate at a rate of combustion of about 10 lbs. per sq. ft. per hour.

able curves with the existing tracks on Sands St., while the north roadway track is also extended across Sands St. to a connection with the existing track on the east side of Washington St., all on the street level.

The New York Terminal.—This may be described as an elevated loop terminal. The north roadway track on its approach to the New York terminal swings to the north, clear of the roadway, by a curve beginning at A, Fig. 1, 365 ft. east of the east end of the existing terminal building. It then ascends on a grade not exceeding 4% to B, 200 ft. from A, the roadway itself being on a descending grade. It then swings back to a position along north side of roadway, but elevated 15 ft. above it, and for 100 ft. to C is on a level. It then descends on a 4% grade to D, 133 ft. from C, where it reaches a level that is 2 ft. higher than that of the existing bridge tracks in the terminal building. Thence, it continues 210 ft. to E, on a level, elevated above the north half of the roadway and parallel with the center line of terminal building. It then ascends a grade not exceeding 5%, still parallel with center line of terminal building, to F, 260 ft. from E, where a half circle begins which has a radius of 57½ ft., and which loops around the west end or face of the terminal building, but above and entirely clear of the Manhattan Elevated Railway station on Park Row, and of the switching tracks of the bridge railway, leaving a clear headroom for the cars of the latter of not less than 15 ft. From the loop the track extends to a junction with the south roadway, and has the same position with respect thereto, and to south side of terminal building, that the track on the north side bears to the north roadway and north side of terminal building.

The 22 sidings are parallel with the main track and on the same level. While there are 22 sidings or car stands, there are but 15 side tracks, including the second loop. Thus, each of the side tracks east of the terminal building has room for two car stands or sidings.

The whole is inclosed by extensions or balconies of the main buildings, which, with the track floors and platforms are supported on columns. The plan does not encroach on private property, all being within the boundaries of land belonging to the bridge, except the loop, which is elevated, as previously described, above structures already existing in Park Row.

The existing main building is substantially preserved, excepting the third and fourth panels from Park Row, where it is necessary to introduce two gables in the roof, one on each side or hip, each 40 ft. wide, and excepting also the glass panels, which give light to the trainshed, and which, for a distance of 400 ft. from the east end, on both north and south sides, are removed, light being admitted to the whole enlarged interior through the glass roofs and sides of the extensions. In place of these panels are iron railings or fences, which, while separating the surface railway tracks and platforms from those of the bridge, do not obstruct the view.

There are 14 stairways provided to reach the passenger platforms of the track floors from the level of the gallery floor of the main building. The aggregate width of these stairways is 64 ft. and their capacity 60,000 people per hour. Four of these stairways ascend direct from the gallery floor, while access to ten of them from the gallery is gained by doorways or passages through the sides of the main building to which they are attached or joined.

Rails.—The rails on the paved bridge approaches are of the girder pattern, 9 ins. deep, and weigh 90 lbs. per yd. On the suspended structure the rails are flat; their surface or tread, flush with the surface of the roadway, has a groove for the flanges of wheels, and their weight is 60 lbs. per yd. They rest upon the lower 4-in. layer of roadway plank. The rails of the New York terminal are of T-section, weighing 60 lbs. per yd.

Cars and Trolley Wires.—A style of closed car generally used on the Brooklyn electric railways is 7 ft. 10 ins. wide and 34 ft. long over all. Its seating capacity is 32 people, while its full capacity is 50 people. Its weight, empty, is 10.55 tons, and loaded, 12.50 to 13.50 tons. It is supported on two four-wheel trucks. The open cars used during summer have a width of 7 ft. 4 ins., and vary in length from 26 ft. to 34 ft. over all. The seating capacity of these cars ranges from 40 to 70 people; but few of the greater length are in service, and these on suburban lines.

On the suspended structure one end of each of the span wires which support the trolley wire is attached to the top chord of inner truss, while the other end is secured to the top of an iron or steel post which rests upon and is fastened to the top chord of outer truss, all well insulated.

Movement and Headway of Cars.—From the published reports of bridge traffic it will be seen that on an average busy day 130,000 passengers cross the river in the cars. Of this number it is estimated that 40,000, and possibly more, are patrons of the surface cars to and from the Brooklyn terminal.

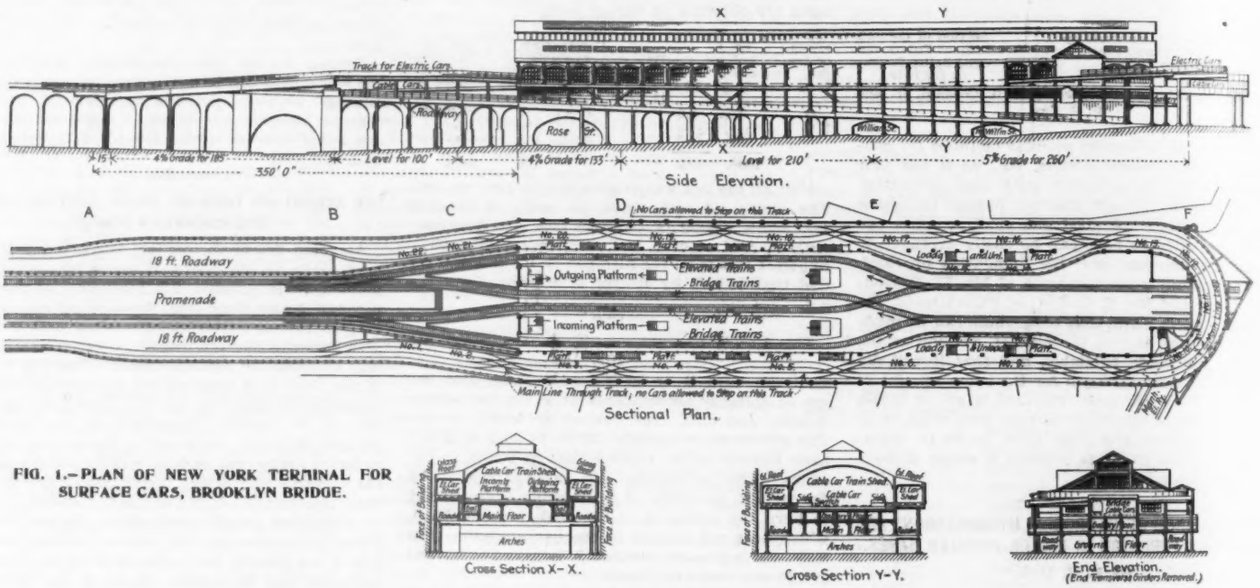


FIG. 1.—PLAN OF NEW YORK TERMINAL FOR SURFACE CARS, BROOKLYN BRIDGE.

Table No. 1 shows the number of surface railway cars that run to or pass near the Brooklyn terminal during each hour of an average day, from 5 a. m. to 12 p. m.

Table No. 1.

	Actual No. cars to or beyond bridge.	Estimate of cars to N. Y. No. per hour.	Passengers. Seating capacity.	Passengers. Maximum capacity.
5 to 6 a. m.....	72	20	640	1,000
6 to 7 a. m.....	178	144	4,608	7,200
7 to 8 a. m.....	270	198	6,336	9,900
8 to 9 a. m.....	398	256	8,192	12,800
9 to 10 a. m.....	390	254	8,128	12,700
10 to 11 a. m.....	364	244	7,808	12,200
11 to 12 a. m.....	346	230	7,360	11,500
12 to 1 p. m.....	304	220	7,040	11,000
1 to 2 p. m.....	338	230	7,360	11,500
2 to 3 p. m.....	384	240	7,680	12,000
3 to 4 p. m.....	394	224	7,168	11,200
4 to 5 p. m.....	420	250	8,000	12,500
5 to 6 p. m.....	498	268	2,576	13,400
6 to 7 p. m.....	460	258	8,256	12,900
7 to 8 p. m.....	312	230	7,360	11,500
8 to 9 p. m.....	304	220	7,040	11,000
9 to 10 p. m.....	252	208	6,656	10,400
10 to 11 p. m.....	248	208	6,656	10,400
11 to 12 p. m.....	212	184	5,888	9,200
Total.....	6,144	4,086	124,752	204,300

It is not claimed that the figures given in Table I., as to number of cars run to New York and their capacity, will ever be fully met in practice. These figures are given rather to illustrate the possibilities of growth, the service the surface railways could perform on days of public celebration, or at times when the bridge railway might be out of order, and as an intimation of the privileges as to headway of cars on the bridge, which they would like to obtain.

Operating Features.—It is proposed that the speed while on the bridge or its approaches shall be about 7 miles per hour. The minimum clear distance between the cars while on the suspended structure and approaches thereto is to be 102 ft. The time occupied by a car crossing will be approximately 10 minutes.

Observations on Surface Railway Plan.—The proposition that surface railway cars should be permitted to cross the bridge has been under discussion at various times, both before and since the completion of the structure. In 1878, Mr. W. A. Roebling, then chief engineer, in a report dated April 5, of that year, described a method of running cars, by means of endless ropes, over tracks laid on the roadways. In 1883 plans were prepared and some preparations made to permit street cars to cross the bridge, but owing to various causes, such as the question of suitable terminal at the street level in New York, the matter of tolls and the lack of money, nothing was done.

It seems fortunate that all this delay has occurred, because the terminal arrangements can now be made to suit the changed conditions resulting from the great improvement within recent years of electric car propulsion.

Strength of the Bridge.—Among those best informed there has never been any doubt as to the ability of the bridge to carry the surface cars with absolute safety. As we have observed, the number of cars on the bridge will vary with the hour of the day, the maximum occurring during the rush, morning and evening. The variations of the number, however, will be gradual, resulting in a fairly uniform distribution of the cars which may at any moment be on the suspended structure.

If there could not be such uniform distribution of the load; that is, if the cars were to be frequently bunched together over one portion of the suspended structure, while other portions were clear, or, if there were a practice of starting a procession of cars 102 ft. apart, across the bridge, while there were none ahead on the roadway, the condition would be unfavorable with respect to the outer trusses.

The outer trusses are 9 ft. high, while the inner ones are 17 ft. 3½ ins. high. The former are, therefore, less capable of distributing the loads to the cables than the latter. In fact, if the unfavorable conditions mentioned were to prevail, it would be necessary to replace the outer trusses with others made higher and therefore stronger, although, not necessarily of proportionally greater weight. So long, however, as the distribution proposed is well observed, and we believe it can be, the outer trusses will have ample strength for the distribution of the loads.

The inner cables have greater permanent and transitory loads than the outer ones, and this would still be true if surface cars were permitted to cross the bridge on the conditions proposed. Of the additional load which the surface cars would bring upon the cables and stays of the main span only 75 tons would be transferred to the inner cables. The effect upon the margin of safety would be inappreciable.

Interference with Vehicle Traffic.—It is very generally asserted and believed that surface cars would seriously interfere with vehicle traffic on the bridge, but there are some considerations that lead us to doubt at least, if they would prove to be more than an annoyance. On a busy day as many as 2,200 vehicles cross the bridge in one direction, but all of them have to stop and pay their toll; for instance, at Brooklyn, 200 ft. inside the entrance, and pass the toll collector in single file. It is obvious that the average speed passing the collector is the measure of the capacity for vehicle traffic and that at that rate and in single file all the vehicles would keep clear of each other. Therefore, as far as actual capacity per hour

or per day is concerned, the presence of cars on one side of the roadway would not affect the result.

It may be claimed, per contra, that better speed can be maintained now, after having passed the collector, than could be if there were cars on one side of the roadway. While this is doubtless true, there is something that may be said to the contrary. Vehicles quite generally cross the bridge in bunches. After passing the collector, the light wagons soon catch up with one or more trucks, and are delayed in getting by. Directly they are joined by others, or they catch up with another slow truck, and all go across the bridge together before they disperse.

A light wagon or carriage will have a better chance to go around a slow truck by watching opportunity to slip in between cars where speed is better, than in attempting to pass, as now, when the truck is often in the middle of the roadway.

The New York Terminal.—The New York terminal under the plan proposed does not present any notable engineering difficulties, either with respect to the construction of its new extensions and tracks or in the moderate changes required of the terminal building and roadways. All of this work can be performed without interruption of bridge traffic of any description. We regard the tracks, platforms and stairways as ample for any probable future business, and believe the terminal can be operated with dispatch and safety.

The only drawback we have noted is, that there will be less light on the roadways and on the gallery and promenade floors than at present. This may require an earlier use of electric lights toward evening, and a longer use of them on dark, cloudy mornings. The side track inside the building on the south side will have to be omitted to avoid removing the relay track of the bridge railway now in place, and which, in our opinion, should remain. The capacity of the terminal will still be ample.

The plan is ingenious and satisfactory, and, to our minds, the best, if not the only workable solution of a difficult problem. It is a credit to the designers, Messrs. Brackenridge and Carver.

Advantages.—It will be seen from the above that if surface cars are permitted to cross the bridge:

(a.) That its capacity for the convenient movement of passengers will be much increased;

(b.) That the congestion on the platform and stairways of the bridge terminals will be greatly relieved;

(c.) That the demands upon the bridge railway train service will be relatively lessened with a consequent possible increase of headway of trains;

(d.) That the stairways at the Brooklyn terminal will be elliminated, so far as surface car passengers are concerned, and also, in most cases, the necessity of transfer, and, finally,

(e.) That the surface cars will be a valuable auxiliary in case of any stoppage of the bridge railroad.

Opinion.—Our opinion is that it is wholly feasible and practicable to operate the surface cars on the bridge, and that the structure will carry the additional load presented with perfect safety, on the following conditions:

1st. That the tracks be placed next the outer trusses.

2d. That the minimum clear distance between cars while on the suspended structure shall be 102 ft.; and that their speed shall not exceed seven miles per hour.

3d. That the operation of cars on the bridge and at the terminals shall be wholly under the control of the bridge authorities and subject to their rules and regulations.

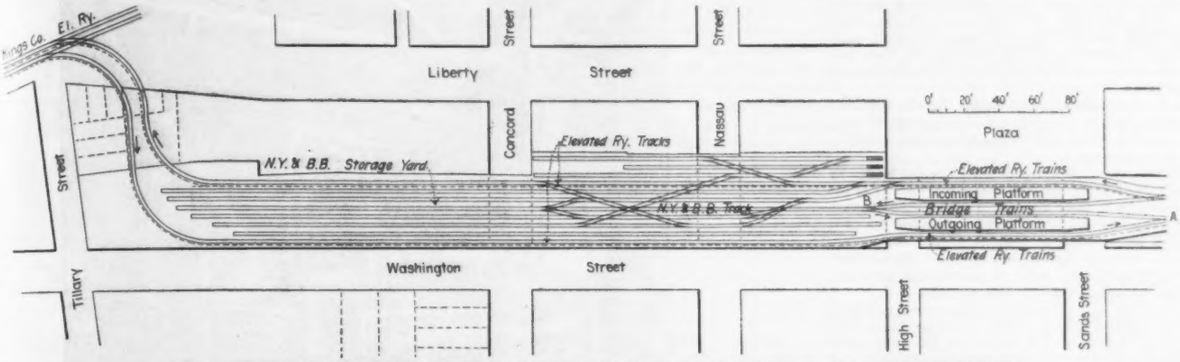


FIG. 2.—PLAN OF CONNECTIONS OF THE ELEVATED RAILWAYS WITH THE BROOKLYN END OF THE BRIDGE.

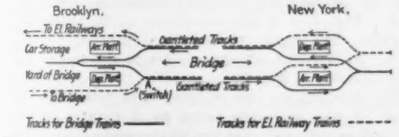


Fig. 3.—Plan Showing Tracks Used by Elevated Trains and Bridge Trains.

Kings County Elevated Ry. We understand that Mr. Cornell is the author of the plan:

Grade connection between the tracks of the elevated railways in Brooklyn and those of the bridge railway.—At a point south of Tillary St. (Fig. 2) connection will be made at grade between the tracks of the Brooklyn Elevated R. R. and those of the Kings County Elevated Ry. on Fulton St. Trains of both elevated companies will therefore approach the bridge from Fulton St. and enter upon the bridge property at or near Tillary St., at which point connection at grade will be made between the tracks of the Kings County elevated and those of the bridge.

Adaptation of elevated trains to cable traction while upon the bridge railroad.—Each elevated car intended to be used upon the railway of the bridge will be fitted with a grip identical in form and construction with that in use upon the bridge cars, together with the same appliances for braking while on the bridge as employed upon the cars of the bridge railway. One car on each train will also be equipped with electric motors on each truck, identical with those adopted by the bridge trustees for the purpose of switching trains at terminals.

Operation of elevated trains upon the tracks of the bridge railway conjointly with bridge trains.—On arriving at Tillary St. station of the Kings County Elevated Ry., the locomotive will be detached from the train while the latter is making the station stop, and pass into the "relay" track to be provided for that purpose. The train will then be drawn by the electric motor car already referred to into the Brooklyn terminus, using the track at the northerly side of the loading platform to the point at which the cable is lifted into the grips, from which point the train will proceed over the bridge by cable traction precisely as the cars of the bridge railway are operated.

Elevated trains returning from New York will enter the track at the southerly side of the unloading platform of the Brooklyn terminal and be propelled by the electric motor car to the Tillary St. station of the Kings County Elevated Ry. on Fulton St. At this point, while the train is making station stop, the locomotive will be attached and the train will proceed in its usual manner over its proper route, either by the grade connection already mentioned to the Brooklyn elevated railroad system, or continue along Fulton St. on the tracks of the Kings County elevated as the case may be. No stops will be made by the elevated trains for the purpose of taking or discharging passengers at the platforms of the Brooklyn terminus, which will be used exclusively for loading and unloading passengers of the bridge railroad.

Bridge trains arriving from New York will use the track at the northerly side of the discharging platform in Brooklyn, and by means of switch at "B," Figs. 2 and 3, will tail switch empty to the track at the southerly side of the loading platform, where they will receive passengers destined for New York.

At the New York terminal the elevated trains will use the track adjacent to the southerly side of the discharging platform for discharging passengers, and will tail switch empty to the track adjacent to the southerly side of the loading platform. The bridge trains will use the track adjacent to the northerly side of the discharging platform for unloading passengers, and tail switch empty to the track adjacent to the northerly side of the loading platform, where they will take on passengers destined for Brooklyn. While upon the bridge the elevated trains will use the down river pair of the gantleted system on each track, both going to and coming from New York; the bridge trains the up river pair in each case.

Passengers for the elevated trains will use the south side of the loading platform in New York, and should be separated from passengers destined for cars of the bridge railway by a fence or partition extending longitudinally of the loading platform. A five-car elevated train will carry a maximum load of 500 people when crowded, or the same as the bridge train of four cars, with 125 persons per car.

Observations.—The minimum headway of trains on the bridge, at present, is 90 seconds, or 40 trains per hour. A minimum headway of 45 seconds, or 80 trains per hour, has been fixed as the limit of capacity of the bridge railway, to be attained, if necessary, after the improvements, now nearing completion, are finished.

Nearly half the passengers of the bridge railway travel to and from the Brooklyn terminal on the elevated lines. Whatever will minister to the comfort and convenience of so large a number of people, 60,000 per day, is of great importance. It is in this direction that we find the principal advantage of the elevated railway plan, for it will do away with the delay, the long walk and the inconvenience of transfer from the elevated cars to those of the bridge railway and vice versa.

As has been described, the plan proposes that all the elevated cars used in bridge service shall have side doorways and shall be fitted with grips and brakes, and a suitable number of motors, identical in form and construction with those of the bridge cars; that the third rail electric system shall supply the power for switching and for hauling the trains between the Tillary St. station and the point where the grips take the cable or drop it, as the case may be, and that the cable shall be used for traction on the bridge precisely as with the bridge railroad trains. The elevated cars are no heavier than those of the bridge; in fact they are somewhat lighter, empty or loaded. It follows that all questions as to headway of trains, methods of operation, and ability of the bridge to carry the load are unnecessary.

The gantleted system of tracks now being laid, as recommended by the board of experts of 1891, will divide the train service into two parts or systems. The plan proposes that one of these systems shall be devoted to the service of the elevated lines, while the other is retained for that of the bridge railway proper.

It is necessary, however, that elevated trains, in entering the bridge property, should run over the northerly track and depart from it over the southerly track of the Brooklyn storage yard of the bridge railway, thus leaving most of the storage tracks available for their present uses.

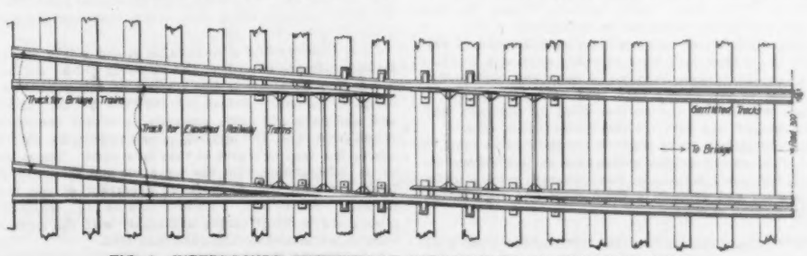


FIG. 4.—INTERLOCKED SWITCHES AT ENTRANCE TO GANTLETED TRACKS.

While this requires some modification of the arrangement suggested by the board of experts mentioned, practically the only change proposed is in the introduction of a pair of movable frogs at the point A west of the loading platform in Brooklyn, Figs. 2 and 3. This will enable the elevated trains to pass from the north side of the loading platform to the down river pair of rails of the north gantlet, over which they must run in order to reach the south

side of the unloading platform in New York, from whence they will tail switch empty to the track on the south side of the loading platform, as previously described.

It would be necessary to interlock the movable frogs mentioned with the signal for starting trains from the loading platform in Brooklyn, and we see no reason why their operation should not be positive and secure.

We regard it as not improbable that if the elevated railways cross the bridge there will be an extension of the Sixth Ave. line of the Manhattan Elevated Railway, in New York, along Canal and Centre Sts., to the New York terminal of the bridge, in which event connection would be made with the bridge railway in such way that its two main tracks, and those of such extension, would be continuous, one with the other. The trains of each elevated company could then run over the tracks of the other. From this would result a heavy increase of travel, especially during the middle of the day, between the West Side in New York on the one hand and Brooklyn, Coney Island, etc., on the other.

We regard the crossing of the bridge by the Brooklyn elevated lines as simply a step in the development of transit between the two cities, which is made possible by utilizing facilities now dormant.

The regularity of the delivery of trains to the bridge by the elevated lines will be the measure of the success of the project. It will be to their interest to make such delivery with exactitude, otherwise it will throw upon them the onus of delays and inconvenience. Besides, should the surface railways also cross the bridge, the elevated lines would have a competitor to deal with of no mean proportions, ready to take advantage of all their failures.

So far as midday and afternoon services are concerned, we think the elevated trains would encounter little difficulty in being promptly on time, but during the rush hours of the morning a train might occasionally be obliged to run by one or more stations without stopping, in order to meet the schedule at the bridge terminal.

If the elevated lines obtain privileges on the bridge, while such privileges are denied to the surface railways, an alternate train service with that of the bridge railway will be required. If, however, both systems get the bridge privileges, the bridge trains will have comparatively little to do; their business will be confined to those who walk or ride in vehicles to and from the terminal, and the intervals between them will be no longer than at present. If, in such event, we assume 60 seconds as the interval between trains while on the bridge, and give the bridge trains proper a four minutes interval, it will provide opportunity for three elevated trains, that is, a Kings County Elevated train once in four minutes, and a Brooklyn Elevated train once in two minutes, a service sufficient for the present, and perhaps for some time to come. This, however, is only an instance of various schedules that may be prepared.

Should the elevated trains cross the bridge each train as it arrives at Tillary St., over its respective railway, should be turned over to a conductor and gripman, employees of the bridge, who should have charge of it during its trip to New York and return, treating it in all respects as they would a bridge train, except in regard to the tracks and platforms devoted to elevated train service.

Opinion.

Our opinion is that it is wholly feasible and practicable to operate cars (trains) of the elevated railways on the bridge, and that so long as the minimum interval or headway of trains is not less than 45 seconds, the structure will carry its own trains conjointly with those of the elevated railroads with perfect safety, on the following conditions:

First.—That cable traction be used on the bridge and electric motor cars for switching trains at the New York terminal, or where required on the bridge system, including the connection tracks between Tillary St. station and the bridge platforms in Brooklyn.

Second.—That all elevated railway cars devoted to service on the bridge shall have side doorways and be fitted with grips and brakes, identical in form and construction with those of the bridge cars, and that, in addition, a sufficient number for the service shall be equipped with electric motors like those of the bridge motor cars.

Third.—That each train destined for the bridge shall be turned over to the bridge authorities at the Tillary St. station, and shall remain in their charge, wholly under their control and subject to their rules and regulations, until it returns thereto.

Method of Operating the Surface Cars in the New York Terminal.

It is intended that each of the car lines shall have its own siding in the New York terminal. Sidings numbered 1, 2, 10, 11, 12, 13, 21 and 22 are lay over or passing sidings. Sidings numbered 3, 4, 5, 6, 9, 16, 17, 18, 19 and 20 are connected at each end directly with the main terminal track, so that a car can run on or off either of them independent of any other car on a siding. Sidings numbered 3, 4, 5, 6, 7, 8, 9, 14, 15, 16, 17, 18, 19 and 20, or 14 in all, are for taking and discharging passengers.

A number of short safety switches of recent design are to be placed where required.

The terminal is to be operated from a signal tower or box located probably above the central tracks of the bridge railway where the best view of the interior of the trainshed and of its tracks may be obtained.

All facing switches are to be moved from the signal box, while all trailing switches are to be automatic. A car on its arrival from Brooklyn will run into the terminal on the main terminal track. If it is a Fulton St. car, for instance, it will run to siding No. 9 and stop in its proper place, the facing switch being thrown from the signal box without delaying the car. The safety gate at the forward end of the car will then be opened, and the passengers will depart, going down the nearest stairway to the gallery, thence to the street. Meantime, the rear safety gate will be opened, and passengers who are coming up the other stairway, or who have been waiting on the platform, will enter the car. Directly the signal to start is given from the signal box, the safety gates will be closed, and the motorman will start the car, which will go ahead on the side track to and through its automatic trailing switch into the main terminal track, which it will follow around the loop and along the south side of the trainshed, and without further stop reach the south roadway track and run across the bridge to the Brooklyn terminal. Thence it will depart without delay over its proper line.

If, by chance, the car following the Fulton St. car into the New York terminal should be another Fulton St. car, the latter would run to lay over siding No. 2, where it would wait until the former had started for Brooklyn, when it would also, on receiving the proper signal, run to siding No. 9, discharge and receive its passengers, and be dispatched for Brooklyn. If the travel to New York during the morning hours on any line, say the Fulton St. line, should at any time be too heavy to be taken care of on siding No. 9, sidings Nos. 1 and 2 could be treated as unloading sidings only; and any car that stopped thereon would discharge its passengers and would then, without further delay, be dispatched to Brooklyn empty.

It should be noted that sidings numbered 3, 4, 5, 6, 9, 17, 18, 19 and 20 can be connected (Fig.1), thus forming a second through track inside the terminal, upon which cars could run around any temporary obstruction at any point on the main terminal track, thus much lessening the probability of a block of traffic.

Since each car line is to have its proper siding and platform, as already described, the traveling public will be divided into 14 small bodies instead of being handled in compact masses. In fact, it is believed that the platforms and stairways will quite generally be simply passageways to and from cars. The approaches to and from the platforms are in the lines of travel as they now exist. There would be no interference with the travel to and from the platforms or with the methods of operation of the bridge railway. Signs and pointers, located in conspicuous places, are to direct people unfamiliar with the surroundings to the platforms and cars they seek.

It is claimed that one minute would be ample time for a car to load and unload its passengers at each of the 14 sidings; in other words, that 14 cars per minute could be received and dispatched to Brooklyn. This is a capacity much in excess of the proposed roadway tracks of the bridge and of any probable requirements.

THE BRYANT REVOLVING MOLDING MACHINE.

We illustrate herewith a new molding machine which was recently put in operation at the foundry of the Bryant Iron Works Co., 1453 Niagara St., Buffalo, N. Y. It is the invention of Mr. Orrin Bryant, general manager of the company, and in its present form is the result of several years' experimental work. The machine belongs to that type of molding machines in which a rotating table carries a series of flasks and passes each of them successively through the different operations required for making and preparing a sand mold for casting. Fig. 1 is a photograph of the machine as set up. In the front is shown a flask containing one-half of a mold for casting a section of a steam radiator. Six of such flasks are carried on the rotating table of the machine. The stationary base of the machine consists of an

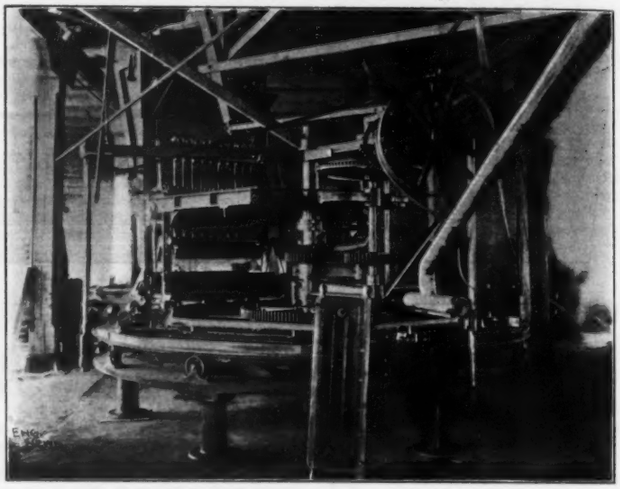


FIG. 1.—THE BRYANT MOLDING MACHINE, PERSPECTIVE VIEW.

annular table about 12 ft. diameter, supported by short iron columns. Radiating arms connect this table with a hub, in the centre of which is a vertical shaft extending from the floor to the top of the machine. On rollers on top of this table is mounted the rotating table. Fig. 2 is a vertical section and Fig. 3 a plan of the machine, showing the ramming device at its extreme left position. Fig. 4 is a side elevation of the ramming device. The table is operated through gearing from the driving pulleys shown in the upper left hand corner of Fig. 2.

The mechanism for raising and lowering the flask on the movable table as it rotates is described as follows: On top of the stationary table is secured a raised rib, having an inclined end and a vertical end, which cause the operation of the device while being carried over it by the rotating table, to which it is attached. This rib is located

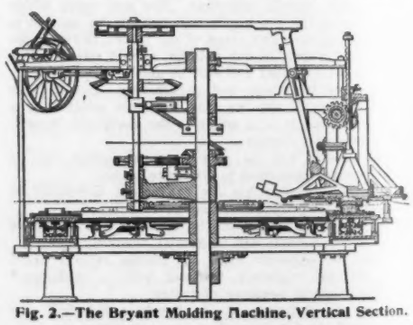


Fig. 2.—The Bryant Molding Machine, Vertical Section.

at the point where the flask is to be removed from the table. A lifting device is provided for each flask.

A horizontally swinging frame carries the ramming hammers, also the sand receiving and depositing mechanism and other operating parts. The box for supplying sand to the flask is rectangular, with one side substantially vertical and the opposite side inclined at an angle of 45°. This sand box moves back and forth across the table and over the vertically movable sand receptacle.

If the sand should be dropped directly into the flask from the reciprocating sand box, so as to fill it with the loose sand, the flask would not be

completely filled when the sand was compacted by the ramming mechanism. To avoid this difficulty, a vertically movable rectangular frame is employed, which rises sufficiently to allow the flask to pass under it without obstruction, and then moves downward and rests upon the top of the flask, while the charge of sand is being put in; also while the ramming and condensing mechanism is in operation. After all this work has been

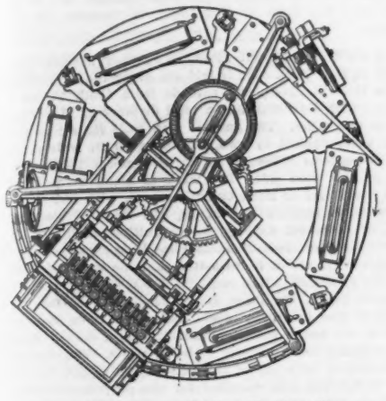


Fig. 3.—The Bryant Molding Machine, Plan.

done and the sand has been condensed properly upon the pattern and so as to project a little above the top of the flask this rectangular frame is automatically moved upward sufficiently to allow the flask, with its packed sand and pattern, to pass under without touching it.

The motion of the scraper for removing the surplus sand is such as to leave the sand deeper at the front and rear than in the center of the flask. This scraping device is an important feature, because the sand in a mold must be packed harder in some parts of a flask than in others, especially at opposite sides of the flask. Different shapes of patterns require different treatment in this respect and for this reason the motion of the scraper can be adjusted to meet the requirements.

After the sand box has deposited a charge of sand in the flask an intermediate pressing platen comes into action. This platen is perforated in order to allow for the full escape of the air in the loose sand. At the moment the platen reaches the limit of its downward movement the ramming hammers drop and strike a heavy blow on the top felt of the platen. When desired the action

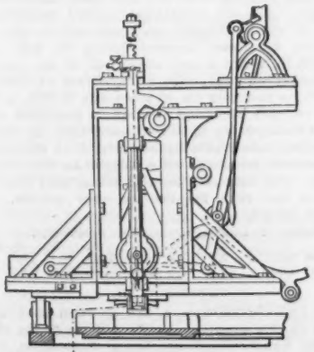


Fig. 4.—The Bryant Molding Machine, Side Elevation of the Ramming Device.

of the hammers may be stopped without interfering with the rest of the machine. After the flask has passed the pressing and ramming mechanism it passes under the smoothing or leveling roller for the purpose of further condensing and leveling the back of the mold. This roller is made in the form of the frustrum of a cone, Fig. 3.

After the flask has passed under the smoothing roller and been leveled it has been found that from the springing of some of the parts or for some other reason the sand still projects up above the top of the flask from 1-64 to 1-32 in. A scraper removes this surplus sand as it passes from under the roller.

The above operations are continuous. While one flask is being put on to the table the one preceding it is operated upon under the horizontally swinging table, and when it leaves the swinging table another flask takes its place. The Bryant Iron Works Company, who constructed and are operating this machine, and who own the patents for it have applied it to the manufacture of radiators in their present plant. They contemplate building a large machine and with it will greatly increase their output. In a recent test of the machine 107 perfect molds for 5-ft. radiator loops were molded, with cores set, and delivered at the cupola in less than 30 minutes. An expert hand molder can turn out about 25 to 30 molds in a day of 10 hours. The Bryant machine will, it is claimed, turn out 2,700 molds in the same time, and in better shape, giving castings of more uniform quality.

THE EADS JETTIES AND THE PASS-A-LOUTRE CREVASSE.

Members of the House River and Harbor Committee have lately inspected the jetties and the crevasse in the Pass a Loutre, at the mouth of the Mississippi River. At the official meeting of this committee, during the trip of inspection, Mr. E. L. Corthell, M. Am. Soc. C. E., presented an exhaustive review of the situation at the mouth of the river, and the history of the jetties and subsequent events is so tersely put, and the subject itself is likely to prove of such general importance, that the following abstract of his address is made:

Previous to 1877 the government made strenuous efforts, by dredging, to maintain through the bars at the South West or North East Passes a depth of 18 ft. in a narrow channel 1¼ miles long. As early as 1873 a board of United States officers was ordered to report upon the practicability of improving one of the natural outlets of the river; and they reported adversely on Jan. 13, 1874, upon the jetty plan. They were of the opinion that the foundation was unstable, the necessary work costly and difficult to build, and the sea end of the jetties would be washed away, and that there would also be an accelerated advance of the bars. In February, 1874, Mr. James B. Eads made a formal proposition to the government to open the mouth of the river and to maintain a deep channel between South West Pass and the Gulf of Mexico, on the principle of "no cure no pay." A heated controversy followed, and as an outcome of this a board of three military and three civil engineers was appointed by the President and sent to Europe to study jetties there. This board reported on Jan. 13, 1875, in favor of the jetty plan and selected the South Pass as adequate to the demands of commerce at that time. For a minimum channel depth of 25 ft. their estimates for construction and maintenance were $7,942,110 for the South Pass, and $16,053,124 for the South West Pass. Soon after the reception of this report, Mr. Eads made a second proposition to make a 30-ft. channel at the South West Pass and maintain it for 20 years. He advocated this pass because he deemed the South Pass too narrow, the bar at its head difficult of removal and the 12-mile channel through it too small for easy navigation.

The House passed a bill for the South West Pass, on the unanimous recommendation of the Committee on Commerce, but in the Senate the bill was amended to apply to the small pass on the ground that this was the line suggested by the board of Army Engineers and the special board. The Senate Committee was immovable, and told Mr. Eads that it would place the improvement of this smaller pass in his hands if he would give the same depth and the same guarantees as he did for the South West Pass, and build the work for $5,250,000 and maintain them for 20 years for $100,000 per year. The amended bill was finally passed by both houses on March 3, 1875. The dimensions of width of channel proposed for the larger pass were retained in the bill, which required the channel to be 30 ft. deep and 350 ft. wide from deep water in the pass to deep water in the Gulf. Through the pass itself and the shoal at its head, the only requirement was "a depth of 26 ft." This bill was amended in 1879 reducing the dimensions of the channel so as to read "26 ft. in depth and not less than 200 ft. width at the bottom, and 30 ft. deep without regard to width."

Mr. Corthell then pointed out the disadvantages of the three dimensions required for the channel through the jetties. They made dredging imperative and proved that the artificial dimensions fixed upon by a Congressional Committee were difficult of maintenance by natural agencies. The problem was further complicated by the great depth and volume of water in the adjacent passes, which were generally 30 ft. deep as opposed to 15 ft. in the South Pass. The concentration of water into the small pass was almost literally uphill work, and the enlargement of the section of the deep passes had to be checked by building mattresses across them.

As to the Pass a Loutre crevasse, it appears that the jurisdiction of the Mississippi River Commission extends from Cairo to the head of the passes, and the Eads contract embraces the head of South Pass, with a right to work in the adjacent water. As a consequence, Pass a Loutre, below the mattress sill, was in a "no man's land"; unnavigable and neglected in all its lower ramifications. It was in this unwatched territory that the river cut through its own bank, about 1½ miles below the head of the works at South Pass, in January, 1891. The surface slope was about 2¼ ft. and the cut rapidly enlarged and increased the current velocity to the head of South Pass and deepened the channel near these works from 20 to 60 or 70 ft. The Eads executors, seeing that the waste of water was robbing the South Pass of its normal flow, expended about $150,000 in attempting to close the gap, but they were unsuccessful after three attempts and abandoned it. This crevasse is now 2,250 ft. wide and from 25 to 60 ft. deep. It has increased the flow through Pass a Loutre from 45% of the total flow of the river to 51%, and has decreased the flow through the South Pass from about 10.5% or 11%, to 7%, or has reduced the volume of flow in this pass one-third. As a consequence, the South Pass is shoaling to the danger point.

Mr. Corthell says that the mischievous crevasse should be closed, and he believes that this could be done in one season of low water for the $250,000 provided in the House bill No. 9492, now pending. As to the duty of closing the crevasse, Mr. Eads' contract of 1875 was based upon normal conditions; but, says Mr. Corthell, the crevasse at Pass a Loutre is an "act of God," creating abnormal conditions. Mr. Corthell concluded by outlining the territory depending upon the mouth of the Mississippi River for an outlet, and the commerce already using that route, and he practically advocated the improvement of the South West Pass to a depth of 30 ft.

THE NEW YORK CYCLE EXHIBITION.

The Cycle Show held at the Grand Central Palace, 43d St. and Lexington Ave., from Feb. 6 to 13, inclusive, was the largest exhibition of the kind that has yet been held. The number of visitors was over 122,000, that of the last four days being in the neighborhood of 20,000 each, which was sufficient to occasion during some hours of the day a crowding too great for comfort. From the point of view of the ordinary visitor, the show was everything that could be desired, except in that the number of makers of wheels was so great that he could not in a single day's visit examine a tenth part of them. Whether the show was a success from the standpoint of the manufacturer is a debatable question, and some officers of the Cycle Board of Trade are not in favor of having any more such shows in the future. They are very expensive, they are held at a time in the year which seriously interferes with agents' business, and if held earlier each manufacturer's new method of construction would be exposed so early as to be in danger of being copied by his competitors during the same season.

There were a great number of novelties shown in the construction of details of the bicycle, some

of which may prove to have merit after they have been tried for a long enough time, but there is no radical improvement in the cycle of 1897 over that of 1896. The chainless bicycle has not yet arrived. A few chainless wheels were exhibited, but their merit remains to be proved. The controversy between single and double tube tires still rages, both of them apparently being equally objectionable, and no better tire yet being in sight. Ball bearings show a tendency in the direction of fewer and larger balls. Wooden rims have become universal, steel and aluminum rims having almost, if not entirely disappeared. Wooden handle bars are becoming common and threaten to displace steel ones. One maker has produced a frame made of wood, but it is not likely to become a favorite. The price of a high-grade bicycle is to remain at $100, nominally, but some dealers will give away a large part of the trade discount. The second grade wheels are listed by different makers from $75 to $45, and it would require an expert to find any difference between the wheels at these two prices.

A LARGE CAR TRANSFER STEAMER, the "Pere Marquette," has been built by F. W. Wheeler & Co., of West Superior, Wis., for the Flint & Pere Marquette R. R., to run between Manitowoc, Wis., and Ludington, Mich., 53 miles. The vessel is 350 ft. long, 56 ft. beam, 19 ft. 6 ins. deep, below main deck 19½ ft., and 36 ft. 3 ins. deep from the upper deck to the floor. It has four tracks and a capacity of 30 cars. With this load and 200 tons of fuel the draft of the ferryboat would be 14 ft. The hull is of steel and has six watertight transverse bulkheads dividing it into seven compartments. The forward plating is ⅝-in. thick and is double for a distance of 60 ft. back of the stem. The frames are steel channels 12 × 3 ins., spaced 24 ins. apart amidships and 14 ins. forward. The boat is propelled by twin screws 11 ft. in diameter, driven by compound engines with cylinder 27 and 56 ins. diameter and 36 ins. stroke. These engines develop a maximum of 3,500 I. HP. and will give the boat a speed of 15 miles per hour. Steam is furnished by four cylindrical boilers, each 15 ft. 3 ins. diameter and 12 ft. long, carrying a working pressure of 130 lbs. per sq. in. Each boiler has four furnaces.

A DEEP WATER HARBOR AT MAZATLAN, on the west coast of Mexico, is to be provided by the Mexican government through a contract lately made with O'Connor & Smoot, of Galveston, Tex. Mazatlan has from 15,000 to 20,000 inhabitants and is the centre of a country rich in mineral and agricultural resources. Surveys for the harbor are to be made jointly by the government and the contractors, and the estimated cost of the improvement is between $15,000,000 and $20,000,000 Mexican money. Col. A. T. Wrotnowski, M. Am. Soc. C. E., and Director of Harbor Works at Vera Cruz, is said to be reporting on the feasibility of constructing deep harbors at Altata and Culiacan, the former place being the best western terminus for the Occidental Railway.

FRENCH MARINE ARCHITECTS are exercised over a recent accident at Havre. A 2,500-ton, three-masted, steel sailing ship, the "Jacques," was launched from the shipyard at Craville and was later moored in the Tancerville Canal alongside a quay to receive her equipment. When the sluice-gates in the dock were opened the vessel gradually listed and then "turned turtle," after breaking off her masts by striking them on the opposite quay. The damage is estimated at $40,000, and opinions are divided as to whether the direct cause of the accident was insufficient ballast, or was due to an inherent defect in construction; it is said the ship had a heavy list when launched. The dimensions of the "Jacques" are not stated, but she was designed especially for great speed, and she was expected to beat the record among sailing ships.

THE ADVANCEMENT IN ECONOMY OF THE MARINE steam engine was thus summarized in a recent paper before the Engineering Society of Liverpool: In 1840 one kilogramme of coal gave a speed of 8 knots to a weight corresponding to a displacement of 1.28 metric tons. But in reality the useful weight was only one-tenth of this quantity, as nine-tenths was taken up by the dead weight of the hull, machinery and fuel. In 1850, with iron ships and screw propulsion, this weight was raised to 1.32 tons and the speed to 9 knots; but the useful weight was raised to 27% of the total displacement, or 0.36 tons. In 1860, with high pressure boilers and surface condensers, a speed of 10 knots was given to 1.8 tons of displacement, and the useful weight touched 33%, or 0.60 tons. In 1870, with compound engines, a speed of 10 knots was given to four tons of displacement, and the useful weight reached 50%, or about 2 tons. In 1885, merchant steamers had a speed of 8½ knots for each 7.5 tons of displacement, with 60% of useful weight, or 4.5 tons. At the same time the enormous transatlantic steamers acquired a speed of 12 knots for each 6.9 tons of displacement, with 55% of useful load, or 3.8 tons. In modern steamships of great speed, for passenger transport mainly, the useful weight does not exceed 0.2 tons.

A PNEUMATIC GRAIN ELEVATOR, on the principle invented by Mr. F. E. Duckham, M. Inst. C. E., as described in Engineering News, Nov. 19, 1896, has been built by the East Ferry Road Engineering Works Co., of London, for use on the Danube River. This vessel, the "Principele Carol," is of steel, 130 ft. long, 22 ft. beam, 11 ft. deep. The machinery, as described in "Engineering," of London, consists of two multitubular marine type boilers 9 ft. 6. ins. diameter by 10 ft. long, and each boiler has two furnaces 2 ft. 4½ ins. diameter. The pneumatic engines are of the horizontal type, having a high-pressure cylinder 22 × 48 ins. and a low-pressure cylinder 42 × 48 ins. There are four air cylinders, each 38 ins. diameter, and the engine will develop 470 I. HP. The air is exhausted by the pneumatic engine from two large steel tanks or receivers placed 30 ft. apart, amidships of the vessel, and carried on steel trestle towers. The extreme height of these structures is 61 ft. above the water level, and is sufficient to allow the grain to run by gravity through the shoots into the largest ocean vessel. The suction pipes through which the grain is lifted from the barges into the receivers, can be attached on either side. The grain falls to the bottom of the receivers, and the air is separated and drawn off from the top. The grain passes from the receivers through suitable ports into automatic dumping boxes. These boxes are divided into two air-tight sections, and oscillate on pivots, so that one side is being filled with grain as the other is discharging its load, the weight of the grain on one side or the other giving the necessary see-saw movement to the apparatus. The grain then falls on to iron trays resting on pivots fore and aft, so that it can be delivered down the incline given to the trays on whichever side may be desired. The exhaust air, after leaving the pneumatic cylinders, is delivered into quieting chambers placed at the extreme ends of the boat, and thence escapes without noise into the atmosphere. The elevator will transfer 140 tons per hour at a very low cost, the captain, with four deck hands, an engineer and fireman forming the crew. The pipes and shoots are manipulated by cranes attached to the towers, and they can be swung inboard when not in use. The aerating action of the air in the pipes has an extremely beneficial action by absorbing the moisture; the process acts as a preventative to any tendency to heating which freshly garnered grain might otherwise develop during its ocean voyage.

THE GANTLETED TRACKS ON THE BROOKLYN Bridge were put in service Feb. 14, and the headway between trains has been reduced from 80 to 75 seconds. The use of two tracks at each platform by this arrangement considerably reduces the crowding during the busy hours.

THE GRADE CROSSINGS AT WASHINGTON, D. C., have long been objected to, and numerous plans have been prepared by the railway companies and the city authorities. The Pennsylvania R. R. wishes to depress its tracks, but the Engineer Commissioner of the District of Columbia, Major Powell, reports in favor of elevating the tracks.

A FAST RUN BY A SPECIAL TRAIN was made Feb. 15 from Chicago to Denver, 1,026 miles, over the Chicago, Burlington & Quincy R. R. and the Burlington & Missouri River R. R. The run was made in 18 hours, 52 mins., or at the average running speed of 0.905 mile per minute, or 54.3 miles per hour. The train was run for Mr. H. J. Mayham, of Chicago, whose son was dangerously ill at Denver.

THE DULUTH & SUPERIOR BRIDGE, at Duluth, Minn., is to be completed in April, and will accommodate street traffic and steam and electric railway traffic. The bridge is 1,094 ft. long, with a drawspan of 491 ft., and a headway of 20 ft. The draw is operated by electricity. Mr. Alfred P. Boller, M. Am. Soc. C. E., is the engineer; Alexander McGraw, of Philadelphia, Pa., is the contractor for the piers, and the Pennsylvania Steel Co., of Steelton, Pa., has the contract for the superstructure.

THE BUDAPEST ELECTRIC UNDERGROUND TRAMway, opened on May 1, 1896, carried 2,261,940 passengers up to Oct. 1, 1896; and in this five months the single car mileage was 229,302 miles. The concession has a life of 90 years, but the city has reserved the right to buy the road in 1940. For the first 20 years the city obtains no revenue from the operation of this road, but for the first ten years thereafter it obtains 1% of the gross receipts, and during the following years the payment advances regularly until it amounts to 5% at the end of the concession. The road and its rolling stock were fully illustrated in our issue of March 21, 1895.

A TUNNEL HALF A MILE LONG has been driven into the old Buck Mountain colliery, the pioneer colliery of the Lehigh coal region, according to the Hazleton, Pa., "Sentinel." The tunnel will drain the water and also serve as an outlet for the coal. The mine has not been worked for several years. Recent surveys shows that it contains a vast amount of coal hitherto unsuspected. The stripping of the whole of the old No. 1 Buck Mountain basin is under consideration. It is expected to yield 2,000,000 tons of coal for a removal of about 5,000,000 cu. yds. of material. This open-cut method of mining or quarrying coal is becoming somewhat common in the anthracite region.

THE WATER POWER OF TRENTON FALLS is proposed to be developed for power purposes by the construction of a dam across the Delaware River. Mr. A. E. Kuser and Mr. John T. Van Cleef, of Trenton, are interested.

THE HARLEM RIVER SPEEDWAY, now nearing completion in New York city, is laid out along the west shore of the Harlem River, and extends from 155th St. to a junction with Dyckman St.—a total distance of 11,500 ft., or over two miles. The general plan calls for a roadway 95 ft. wide, flanked by two tree-spans 10 ft. wide each, with an easterly sidewalk 20 ft. wide and a 15-ft. sidewalk on the west side. The work is being carried out under the Board of Park Commissioners, with Mr. G. A. Lockwood as engineer in charge, and Prof. William H. Burr, of Columbia College, as consulting engineer. To the present time about $1,932,000 has been expended upon this speedway, and it is estimated that the total cost will be about $2,250,000. One rock cut, 1,000 ft. long and 110 ft. to the top of the inner slope, has cost $192,000. No provision was originally made for shade trees, and as much of the filling material was cinders, a trench lined with masonry and concrete is being made. This trench is objected to by some of the newspapers of the city as being watertight and unsuited for the purpose intended. But Prof. Burr says it is not watertight and is simply provided to hold the soil necessary for the growth of the trees.

THE PHILADELPHIA PUBLIC BUILDING, say the Directors of the Master Builders Exchange of that city, has cost, so far, $1.60 per cu. ft., as compared with 60 cts. per cubic foot for the Government Library at Washington, the latter building being classed as unexcelled in workmanship and material. The exchange has made formal complaint against the system of unbalanced bids which has prevailed in the letting of work for the Philadelphia structure. It claims that a previous knowledge of what would and what would not be demanded of the contractor, has enabled a favored few to bid abnormally low prices on things not actually needed and to make great profits on the articles supplied. The Master Builders ask for clearer specifications and more time for making bids.

THE TOWER ON THE PUBLIC BUILDINGS at Philadelphia has cost $835,439 for the metal work alone, under the contract with the Tacony Iron and Metal Co. At a late meeting of the Public Buildings Commission it was stated that under the 15% commission granted to this company by the contract the company had already received $125,000. All the metal work is now either erected or on the ground, and it is proposed to close accounts with the Tacony company.

THE BOSTON MANUFACTURERS' MUTUAL FIRE Insurance Co., in its report for last year, shows that the company now has 869 members and risks amounting to $108,443,199. The net premiums received amounted to $853,776, of which $560,291 were returned in the form of dividends, the losses incurred during the year being only $55,285.70, which is only about 1-20 of one per cent. of the amount at risk. The average rate of dividends returned to its members for 46 years was 71.97%, and for the last five years 77.2%. A diagram is presented which shows that the tendency in recent years, since the general use of modern safe-guards against fire, is to making the ratio of losses to premiums more uniform as well as lower in amount. The following figures, taken from this diagram, show the ratio for two six year periods, viz.: 1871-6 and 1891-6.

Ratio of Losses to Earned Premiums.

Year.	1.	2.	3.	4.	5.	6.	Av'e.
1871-76, per cent....	3.7	37.3	60.6	44.5	10.4	29.9	31.1
1891-96, per cent....	38.9	7.4	24.5	3.8	38.1	6.5	19.9

SMOKE PREVENTION is a live question in England as well as in this country. In the address of the chairman of the Manchester Steam Users' Association at its last annual meeting he quoted with approval the following extract from the report of a committee of the Manchester and Salford Association for the Abatement of Noxious Vapors:

The committee would express their opinion that in the great majority of cases the black smoke thrown into the air during the combustion of coal is preventible, either by hand or mechanical firing and without great cost to the consumer . . . . . and that where live firebars are adopted, i. e., where the bars have an automatic reciprocating motion an inferior and cheaper quality of coal can be used. To sum up in one sentence the conclusions of the committee as to smoke produced in raising steam: A manufacturing district may be free from manufacturing smoke, at least from the steam boilers with which alone the committee have concerned themselves. Further on the committee express themselves in favor of the prevention of smoke being made compulsory.